AirControlNET

Version 4.1

DEVELOPMENT REPORT

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Prepared for:

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CONTENTS

TABLES AND FIGURES

ACRONYMS AND ABBREVIATIONS

ABS	acrylonitrile-butadiene styrene
AF	air-to-fuel
AIM	architectural and industrial maintenance
BAAQMD	Bay Area Air Quality Management District
BARCT	best available retrofit control technology
CAA	Clean Air Act
CARB	California Air Resources Board
CENSARA	Central States Air Resource Agencies
CO	carbon monoxide
EFIG	Emission Factor and Inventory Group
EGU	electricity generating units
EPA	U.S. Environmental Protection Agency
ERCAM-VOC	Emission Reduction and Cost Analysis Model for Volatile Organic Compounds
ESP	electrostatic precipitator
ETS/CEM	Emission Tracking System / Continuous Emissions Monitoring
FBC	fluidized bed combustion
FGD	flue gas desulfurization
FGR	flue gas reburning
FHWA	Federal Highway Administration
FIP	Federal Implementation Plan
FIPS	Federal Information Processing Standard
HAPs	hazardous air pollutants
Hg	mercury
I/M	inspection and maintenance
IC	internal combustion
ICI	industrial, commercial, and institutional
IR	ignition retard
ISEG	Innovative Strategies and Economics Group
L-E	low-emission
LADCO	Lake Michigan Air Directors Consortium
LEA	low excess air
LNB	low-NO_x burner
LPG	liquefied petroleum gas
MACT	maximum achievable control technology
MARAMA	Mid-Atlantic Regional Air Management Association
MSAs	metropolitan statistical areas
MW	megawatts
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NEI	National Emission Inventory

ACRONYMS AND ABBREVIATIONS (continued)

NESCAUM	Northeast States for Coordinated Air Use Management
NET	National Emission Trends
NGR	natural gas reburning
NH_3	ammonia
NO_x	oxides of nitrogen
NSCR	non-selective catalytic reduction
NSPS	New Source Performance Standards
O&M	operating and maintenance
OAQPS	Office of Air Quality Planning and Standards
OT	oxygen trim
OTC	Ozone Transport Commission
Pechan	E.H. Pechan & Associates, Inc.
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
RACT	reasonably available control technology
REMSAD	Regulatory Modeling System for Aerosols and Deposition
SAMI	Southern Appalachian Mountains Initiative
SCAQMD	South Coast Air Quality Management District
SCC	Source Classification Code
SCR	selective catalytic reduction
SESARM	Southeastern States Air Resource Managers, Inc.
SNCR	selective non-catalytic reduction
SO_2	sulfur dioxide
tpy	tons per year
ULNB	ultra-low NO_x burner
VOCs	volatile organic compounds
WESTAR	Western States Air Resources Council
WI	water injection
WRAP	Western Regional Air Partnership

CHAPTER I
INTRODUCTION

AirControlNET is a control strategy and costing analysis tool developed by E.H. Pechan & Associates, Inc. (Pechan) for the U.S. Environmental Protection Agency (EPA) to be used in conducting regulatory impact analyses of air pollution regulations and policies. AirControlNET is a relational database system in which control technologies are linked to sources within emissions inventories. It contains a database of control measures and cost information for reducing the emissions of criteria pollutants (e.g., oxides of nitrogen [NO_x], sulfur dioxide [SO_2], volatile organic compounds [VOCs], particulate matter with an aerodynamic diameter of 10 microns or less [PM_{10}], particulate matter with an aerodynamic diameter of 2.5 microns or less [$PM_{2.5}$], ammonia [NH_3]) as well as carbon monoxide (CO) and mercury (Hg) from point (utility and non-utility), area, nonroad, and onroad mobile sources as provided in EPA's National Emission Inventory (NEI). As such, AirControlNET is linked to and dependent upon EPA emission inventories as a source of emissions data. The control measure data files in AirControlNET include the control efficiency to calculate emission reductions for that source and cost data (annual and capital) needed to calculate the total annualized costs of applying the control measure.

Table I-1 summarizes the number of control measures within AirControlNET for each sector and pollutant.

Table I-1. Number of Control Measures in AirControlNET by Sector and Pollutant

Major Pollutant	Utility	Non-Utility	Area	Onroad	Nonroad	Total
NH_3	0	0	3	0	0	3
NO_x	26	411	15	15	8	475
PM	24	152	13	13	0	202
SO_2	6	34	1	0	0	41
VOC	0	8	65	5	12	90
Hg	5	0	0	0	0	5

A. DEVELOPMENT HISTORY

Pechan first developed control measure databases for EPA that focused on individual pollutants. In the late 1980s, Pechan developed the Emission Reduction and Cost Analysis Model for Volatile Organic Compounds (ERCAM-VOC) to provide control measures for VOCs. A companion model was developed in 1994 (ERCAM-NO_x) to provide similar information for NO_x control measures. These models were capable of projecting 1990 emissions and costs for all sectors of VOC and NO_x emitters based upon databases of unique growth and control strategy applications. They were used together in a wide range of analyses including examining the national cost and emission reductions associated with the Title I General Preamble, assessing the impact of control measures beyond Clean Air Act (CAA) requirements in support of ozone and particulate matter (PM) National Ambient Air Quality Standards (NAAQS) revisions, and analyses of the progress of individual non-attainment areas towards meeting reasonable further progress requirements.

In the late 1990s, EPA asked Pechan to use *ERCAM-like* equations and methodologies to develop databases of emission sources and potential control measures to support the development and implementation of the $PM_{2.5}$ and 8-hour Ozone NAAQS, Section 812 Prospective Analysis of the CAA, and other policies. These databases were used to assist EPA in analyzing the effects of different standards and/or control strategies. This evaluation forced a movement away from separate single pollutant databases to a single database containing multiple pollutants, with the associated control measures, costs, and effectiveness.

By 2001 – after several revisions and updates – the database became known as AirControlNET–the control measure database for the National Emission Trends (NET) inventory. However, at that time, AirControlNET consisted of more than a dozen programs. A significant effort was undertaken to modify these programs into a relational database system. Revisions were necessary because: 1) the programs were not *user friendly* when it came to updating or adding new control measures, 2) the program logic was difficult to follow since many of the cost equations were hard-wired into the source code, 3) it was very difficult to calculate costs and reductions for any new emission inventories, and 4) too many steps were necessary to process new data.

Today, AirControlNET has evolved into a more user friendly platform and offers new functions for analyzing different types of cost scenarios. An interface was developed that provides increased functionality. Pechan also made important program design changes to improve upon the database input, operations, flexibility, and output generation. These include, but are not limited, to the following:

1. *Facilitate addition or revision of control measure information*. This was achieved by adding all control measure information to data tables used by the program. The previous version had numerous numeric equations for specific control measure scenarios hard-wired into the code. These multiple equations were replaced with a single equation that uses variables related to the control measure databases and emissions inventory. With this format, control measures can be added or revised without program changes. Revisions are accomplished by changing input data files.

2. *Add flexibility in using different emissions input files*. Previous versions of the AirControlNET programs could only apply control measures to the 1996 NET inventory. Revised programs now have the ability to use different base emission input files in order to apply control measures to other years and/or inventories. This is an important advancement to the system, since it is anticipated that comprehensive control measure databases will need to be developed for future year inventories.

3. *Codified and automated the development of the AirControlNET input database*. This greatly reduces the time needed to process new data or emission estimates. New versions of the AirControlNET database can now be prepared in a more timely fashion.

4. *Generate multiple output files to meet specific user needs*. AirControlNET can generate files to meet the individual needs of users ranging from cost inputs for economic impact modeling or emission reductions for air quality modeling, to summary files with more general characterization of selected control measures.

These improvements are expected to make this tool better able to meet the needs of policy analysts and others in conducting control strategy and costing analysis of environmental regulations or policies.

B. OVERVIEW OF AirControlNET

The core of AirControlNET is a relational database system developed in Visual FoxPro version 7.0 in which control measures are linked to emission sources provided in EPA emissions inventories. The system contains a database of control measure applicability, efficiency, and cost information for reducing the emissions of criteria pollutants (e.g., NO_x, SO_2, VOC, PM_{10}, $PM_{2.5}$ with organic carbon and elemental carbon components) as well as NH_3, CO, and Hg from point (utility and non-utility), area/nonroad, and onroad mobile sources. The control measure data file in AirControlNET includes not only the control efficiency and calculated emission reductions as applied for a particular source, but also estimates the annual and capital costs for application of the control measure to that specific source.

AirControlNET relies on the control efficiency, throughput, fuel use, and emission factor data provided in the EPA NEI format to perform cost-related analysis. The control measure information was obtained by examining the technical and cost data from EPA reports and other literature sources. As indicated in Table I-1, AirControlNET currently contains information on several hundred different control measure/source combinations. The control data is accessed through a Cost POD, which is linked to sources by Source Classification Code (SCC), as described in Appendix A of the AirControlNET Documentation Report (Pechan, 2006).

AirControlNET was developed as a Visual FoxPro Application. The user, however, does not need Visual FoxPro to run this tool, as all supporting data files are transferred to the user's computer during installation. The minimum system requirements for installation and operation of AirControlNET include: 1) Windows 98, Windows 2000, or Windows XP; 2) CPU Speed = 233 MHZ,; 3) RAM = 64 MB; 4) Hard Drive Free Space = 650 MB; and 5) Display - Mode VGA/Colors = 256/Resolution = 800 x 600. A CD-ROM drive is required to install the software from an installation CD-ROM. The minimum requirements stated above include those required for the version 4.1 tool and the 1999 control measure dataset distributed with the tool. They do not include additional hard drive free space that would be needed if additional control measure datasets were loaded into the tool. Typical national datasets require between 200-300 MB of additional hard drive space per dataset.

In addition to Visual FoxPro, the AirControlNET application uses two supplementary software products to create the mapping and graphing capabilities within the tool. The first is Graphics Server (www.graphicsserver.com) which is used to automate the creation of customizable plots within the least cost module. The second is Scalable Vector Graphic (SVG) (www.adobe.com/svg/main.html) is used to provide the mapping capabilities within AirControlNET.

C. HOW THIS REPORT IS ORGANIZED

The remainder of this report contains the following two chapters and four appendices:

Chapter II. AirControlNET Database Development: This chapter details the development of the relational database that serves as the core of this tool, i.e., merged database matching of appropriate control measures to emission sources within an EPA inventory.

Chapter III. AirControlNET Control Measure Content Summaries: This chapter provides a listing of the control measures currently in AirControlNET.

Appendix A. Database Structures for control measure data sets: This appendix provides tables with the database structures of these key databases.

Appendix B. Control Measure Summary List By Pollutant: This appendix provides a listing of control measures sorted by pollutant that includes details such as other affected pollutants, control efficiency, and cost-effectiveness.

Appendix C. Onroad Mobile Control Measure Development: This appendix documents the onroad mobile source control measures in AirControlNET.

Appendix D. Non-road Control Measure Development: This appendix documents the nonroad mobile source control measures in AirControlNET.

Appendix E. Database Structures for the control measure exports with column descriptions This appendix provides tables with the database structures of these key databases.

Appendix F. External Software Tools: This appendix describes the 3rd party software products used within the AirControlNET application to create the AirControlNET mapping and graphing capabilities.

CHAPTER II
AirControlNET DATABASE DEVELOPMENT

This chapter provides information on the development of the control measure databases that serve as the core of AirControlNET. It includes information on the database inputs (emission inventories and control measures), file development procedures, and data conversion routines.

A. INPUT DATABASES: EMISSIONS INVENTORY

AirControlNET provides control measure data applied to several EPA emission databases. This section provides an overview of these emissions inventories.

EPA' s Office of Air Quality Planning and Standards (OAQPS) prepares a national database of air emissions information called the NEI with input from numerous State and local air agencies, Tribes, and industry. The NEI contains information on pollutant emissions from stationary and mobile sources for criteria air pollutants and their precursors, as well as hazardous air pollutants (HAPs). The NEI includes annual emission estimates for all sources of air pollutants across all 50 States and the District of Columbia. Emission estimates for individual point sources (facilities), as well as county-level estimates for area, nonroad, and onroad mobile and other sources are included.

The main focus of AirControlNET is criteria air pollutants for which EPA has set ambient health-based standards (http://www.epa.gov/air/urbanair/6poll.html). Four of the six criteria pollutants are included in the NEI database. These are CO, NO_x, SO_2, and primary particulate matter (PM_{10} and $PM_{2.5}$). In addition, the NEI includes emissions of VOCs and NH_3. Ozone, which is one of the six criteria air pollutants, is created by a chemical reaction between NO_x and VOC in the presence of heat and sunlight.

Three general classifications of air pollution sources are contained in the NEI. These are point sources, area sources, and mobile sources.

- Point sources are stationary sources of emissions, such as an electric power plant, that can be identified by name and location. A *point* source emits a threshold amount (or more) of at least one criteria pollutant, and must be inventoried and reported by the States. Applicability limits for States reporting a facility as a point source at the time the NEI databases were prepared were for any point source with actual emissions greater than or equal to any one of the following levels: 100 tons per year (tpy) for sulfur oxides, NO_x, VOC, and PM_{10}; 1,000 tpy for CO; and 5 tpy for lead (FR, 2002). Many States also inventory and report data to EPA for stationary sources that emit amounts below the thresholds for each pollutant. Point sources are often broken up into two categories, Electricity Generating Units (EGU) or utilities and Non-Electricity Generating Units (non-EGU). For EGUs, emissions data are based on EPA's Emission Tracking System / Continuous Emissions Monitoring Data (ETS/CEM). For non-EGUs, emissions data are based on reported State data or older inventories in instances where no recent State data was submitted.

- Area sources are small point sources, such as gas stations or dry cleaners, or distributed stationary sources, such as wildfires or agricultural tilling. These sources do not individually produce sufficient emissions to qualify as a point source. For example, a single dry cleaner within a county will typically not qualify as a point source, but collectively the emissions from all of the dry cleaning facilities in a county may be significant, and therefore are included in aggregate at the county level within the emissions inventory. For these sources, emissions data are most often based on reported State data and supplemented by EPA estimates for some sources, and older inventories where no State is available.

- Mobile sources are any vehicle or equipment with a gasoline or diesel engine. These include both onroad vehicles (cars and trucks) and nonroad (tractors, lawn mowers, airplanes, and ships) vehicles and equipment. Mobile source emissions are usually estimated at the county level. For onroad mobile sources, emissions data are based on the Federal Highway Administration's (FHWA) estimate of vehicle miles traveled and emission factors from EPA's MOBILE Model (EPA, 2002a). For non-road mn mobile sources, emissions data are based on EPA's NONROAD Model (EPA, 2003).

Please refer to http://www.epa.gov/ttn/chief/net/index.html for background and additional information on national emissions inventories including current and future NEI data. Also note that many of the quality assurance checks done on the emissions inventories are completed by the Emission Factor and Inventory Group (EFIG) within EPA's OAQPS. EFIG staff check to ensure that identifiers, such as Federal Information Processing Standard (FIPS) and SCC, are correct and that inventory data are within acceptable ranges.

AirControlNET 4.1 offers flexibility of loading the baseline and user modified emissions data for emission reduction and cost evaluation of control strategies. These data sets have to be in specific defined input format to be loaded into AirControlNET.

As currently configured, AirControlNET can not accept emissions inventory files directly and it is not currently possible for someone to configure an emissions inventory for direct use in AirControlNET. However, if an AirControlNET user is able to provide their emissions data to EPA in the correct flat file format, it is relatively easy for EPA to run the pre-processing software to create a new control measure dataset which can be subsequently imported into the Tool. As described below, the required format by AirControlNET's pre-processing programs is a flat file format.

EPA' s Office of Air Quality Planning and Standards prepares a national database of air emissions information called the National Emissions Inventory (NEI) with input from numerous State and local air agencies, Tribes, and industry. The NEI database is in a defined format called NEI Format version 3 (i.e. NIF3). The detail of this format is provided at http://www.epa.gov/ttn/chief/nif/nif3.html. The data files found at this link provide the field naming convention and data expectations of AirControlNET.

As the required format of AirControlNET's pre-processing program is loosely based on the NIF3 format, the first step to performing this process is to convert the from the EPA's NIF3 emissions data format into a flat file format used by the AirControlNET pre-processor. The conversion to the flat file can be done using database query commands. The required data structures will be provided by EPA upon request.

As currently configured, control measure dataset for Onroad sources are created offline using EPA's Mobile 6.2 emissions model. Onroad control measure dataset are available for the entire country for 1996, 1999, 2001, 2007, 2010, and 2015.

B. INPUT DATABASES: CONTROL MEASURE FILES

AirControlNET includes control measure and applicability information that are organized and linked by Cost POD. A Cost POD is a group of source types, as defined by SCCs, which have similar emission characteristics, control techniques, and control costs. A Cost POD may have one or several control strategies (which consist of control options, efficiency, and cost information). All of the emission reduction and control cost calculations are performed at the Cost POD level as the Cost POD is the data key used to link the control applicability information through the POD/SCC Crosswalk. The source applicability calculations are performed in a pre-processing program that is external to AirControlNET and the details of these calculations are not included there. The control measure data sets used with the AirControlNET tool have this applicability built in to them, by design. The source applicability information (i.e., connection between Cost POD and SCC) for each control measure is defined in the documentation of each control measure. The details can be found in Pechan, 2006.

Information for each control measure has been carefully collected and reported to the EPA through separate reports for various sectors (i.e., area/nonroad, utility and non-utility point, onroad mobile). Important aspects of each control measure, such as application, functionality, cost and control efficiencies were reported at the time of analysis. In addition to the various reports, all the control measure information is outlined in a 2005 report called the AirControlNET Volume III: AirControlNET, Version 4.1, Control Measure Documentation Report (Pechan, 2006). Many of the costs for the controls were derived using information from the EPA Control Cost Manual (EPA, 2002b).

AirControlNET calculates costs by three different methods: using a dollar per ton of pollutant emission reduced, using an equation, or both. Most of the control cost information within this tool has been developed as cost per ton inputs. This can be attributed to the data requirements for estimation based on equations and the fact that parameters used in other costing methods may not be readily available or broadly representative across sources within the inventory. The costing equations used in AirControlNET require either plant capacity or stack flow to determine annual, capital and/or O&M costs. Capital costs are converted to annual costs, in dollars per ton, using the capital recovery factor. The capital recovery factor incorporates the interest rate and equipment life (in years) of the control equipment. Control measure costs identified as "both" use equations unless plant capacity or stack flow data is incomplete in the EPA emission inventories. In that case, a default dollar per ton of pollutant reduced value is applied. Detailed documentation for all costing methods is provided in AirControlNET Volume III: Control Measures Documentation (Pechan, 2006) along with descriptions of control measures and emission reductions.

AirControlNET 4.1 allows users to modify some parameters of control measures to perform sensitivity analysis. To prevent ambiguous results, quality assurance of modified parameters is done by allowing user to modify parameters only within certain ranges. Error messages are reported to users and control measures with errors cannot be saved by the user. Sensitivity analysis results can be seen on-the-fly, as well as, permanent emissions datafile with modified controls can be made with AirControlNET 4.1.

AirControlNET 4.1 also allows users to add mobile controls through that Mobile Measures Tool. This tool does not allow users to add duplicate controls to AirControlNET and allows creation of new data sets with new Mobile controls. These data set can be used by Control Scenario Module (CSM), Least Cost Module (LCM) and reporting module.

C. OVERVIEW OF MEAS_ALL FILE DEVELOPMENT

Figure II-1 provides an overview of the two-step automated process that creates the control measure data file required by AirControlNET. Each of the modules requires two inputs: 1) an emissions inventory, 2) control measure information, and applicability information as described above.

The first step, as shown in Figure II-1a, involves the main program “make_meas_all.prg” that runs three separate module for each of the three major sectors: non-utility point sources, utility sources, and area sources. Each of the three modules uses a flat file format of the NEI inventory as the starting point for the process. The three modules contain the coding necessary to link the control measure data as described above (i.e., control measure, control efficiency, costs, and applicability) into the EPA emission inventories. The Cost POD data field serves as the linkage between the emissions inventory and the control measure information. As noted above, this link is performed external to AirControlNET. Control measure reductions and costs are estimated within each module using control efficiency, capital cost, operating and maintance costs. Please note that the on-road mobile and nonroad sources are processed independently as detailed in Appendix C and D, respectively.

In the second step of the MEAS_ALL file development process, as shown in Figure II-1b, the output files from each of the three module are merged with each other and the two mobile source data files thereby creating the control measure data file named meas_all.dbf. A detailed description of the structure and contents of meas_all.dbf is provided in Appendix A.

As part of this development process, Pechan conducts several quality assurance/quality control checks for each of the major sector pollutant modules used to develop the AirControlNET database. Most of these checks determine whether the emissions inventory data are in acceptable ranges. Examples of fields that are checked for valid ranges include control efficiencies of current controls, stack flow rates, and capacities. Rule effectiveness, rule penetration and control efficiency are checked to ensure that they are in percentage format (e.g., 95 instead of 0.95). Rule effectiveness is set to a default value of 100 percent for values listed as 0 percent. Boiler design capacity and stackflow are checked to ensure the proper units (megawatts [MW] and cubic feet per minute, respectively). The pollutant modules also check for unreasonable control

Figure II-1a. Modules for Development of Non-EGU Point, EGU, and Area Source Files

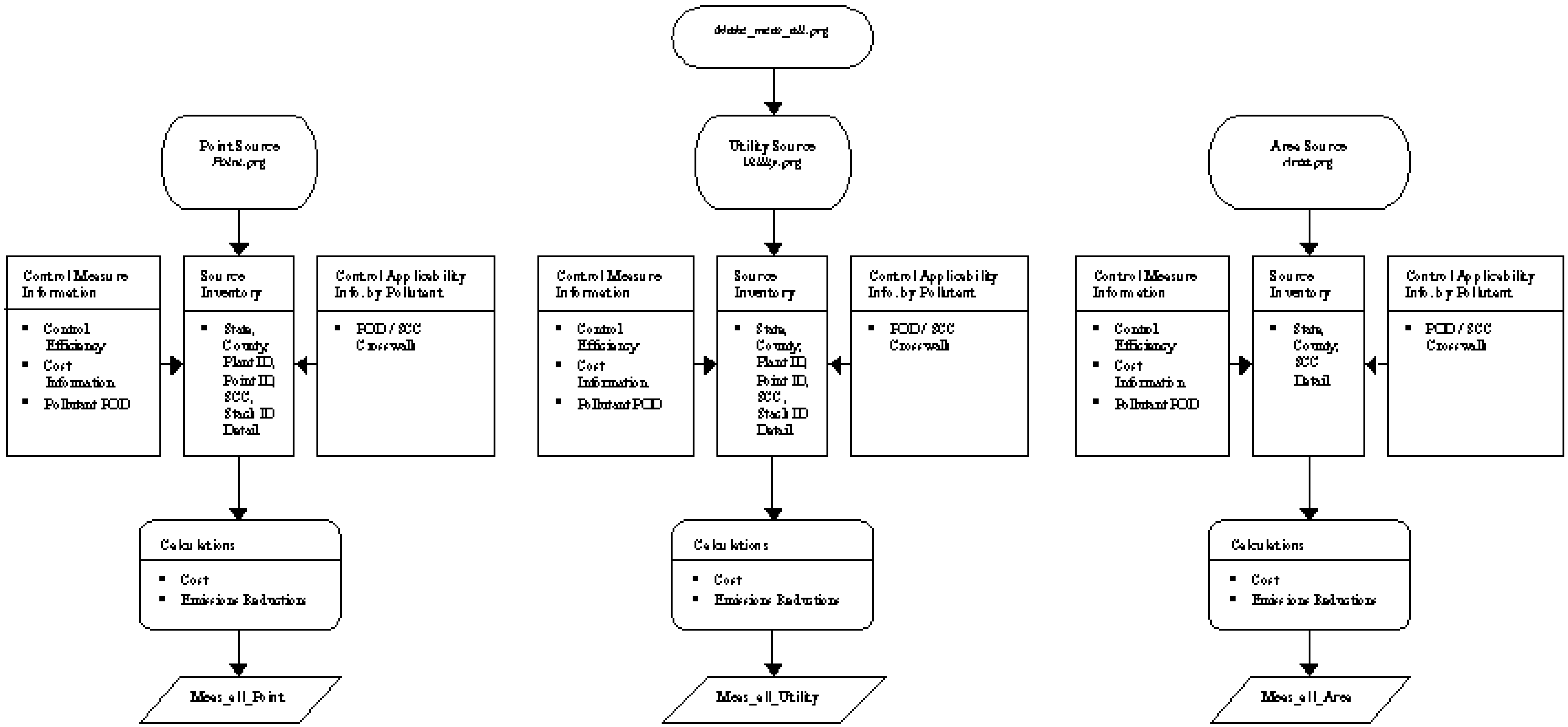
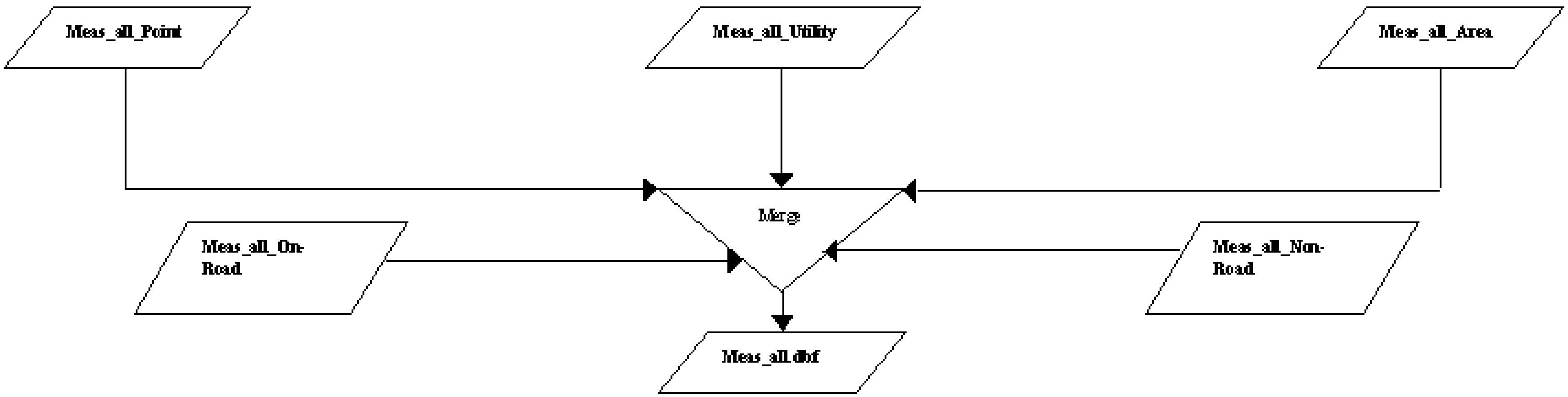


Figure II-1b. Final Merge of Source Files



efficiency values and reset them to appropriate values. The maximum control efficiencies are 95 percent for NO_x, 99 percent for VOC, 99.99 percent for SO_2, 99.5 percent for PM and secondary organic aerosol control efficiency values must be equal to VOC control efficiencies.

D. NEW DATABASE DESIGN REASONING

The previous release of AirControlNET contains more than 1.5 GB of data. In 2004 Pechan was tasked with adding three years to AirControlNET which would have doubled the size of the current data set. Redesigning the database structure significantly cut the size of the files and allows for improved AirControlNET functionality.

When AirControlNET was first designed, the data set was small compared to the present. Because of this, a database design that required one flat file to be implemented was selected which sacrificed disk space for the fastest return of results. As time progressed, more data was added to the initial data set.

Pechan therefore implemented a new design that reduces the size of repeated information but retains a familiar structure so that frequently used data is quickly accessed. Implementing the new database design required application wide changes to the code, but drastically improved the space consumption of the AirControlNET files as well as eliminate current ambiguities in the code.

E. OVERVIEW OF CONVERTING MEAS_ALL INTO AirControlNET INPUT FILES

With the advent of the new database design, AirControlNET input files are grouped into data sets that represent a base or modified emission year. Each data set consists of 14 table files and two index files which can be joined together to produce identical output as previous versions of AirControlNET.

Figure II-2 provides the process by which the meas_all_<year> database (e.g., meas_all_1996.dbf) is converted into an AirControlNET data set. As shown, this process involves two separate programs (i.e., acn_CalculateIncrementalData.prg and acn_CreateDSFromMeasall.prg) that serve to reformat data and add information in order to develop the data set files for AirControlNET. Table II-1 lists the file names of the AirControlNET input data tables. Figure II-3 shows the data relationships of the tables listed in Table II-1. The primary data keys are labeled as PK in Figure II-3.

The program acn_CalculateIncrementalData.prg:

- takes the unmodified meas_all_<year>.dbf as an input.

Figure II-2. Overview of Core AirControlNET Database Development

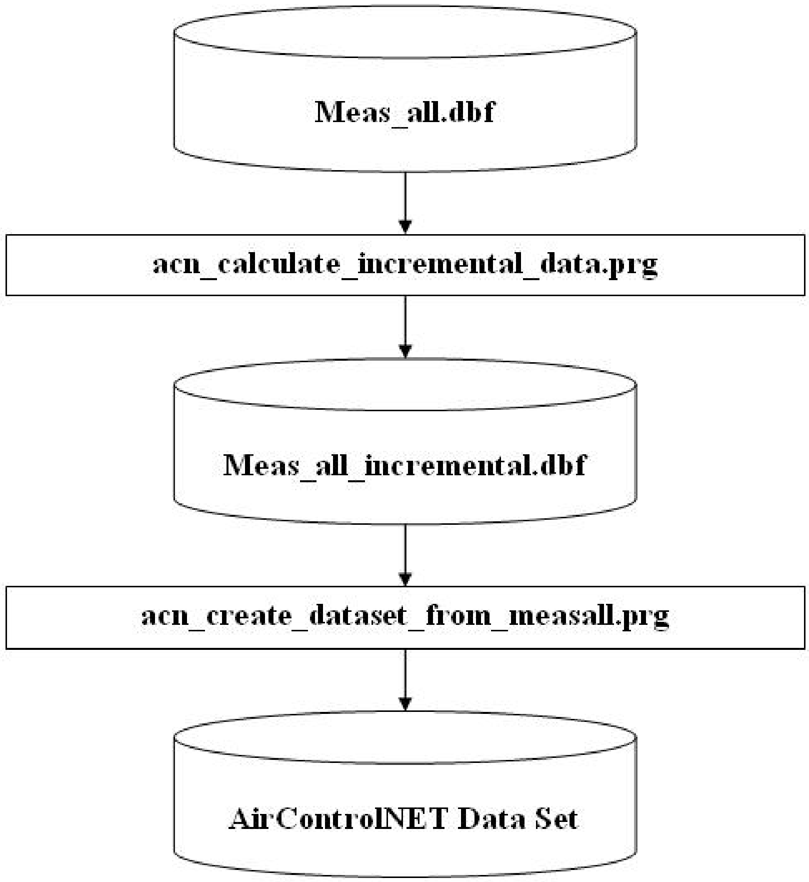
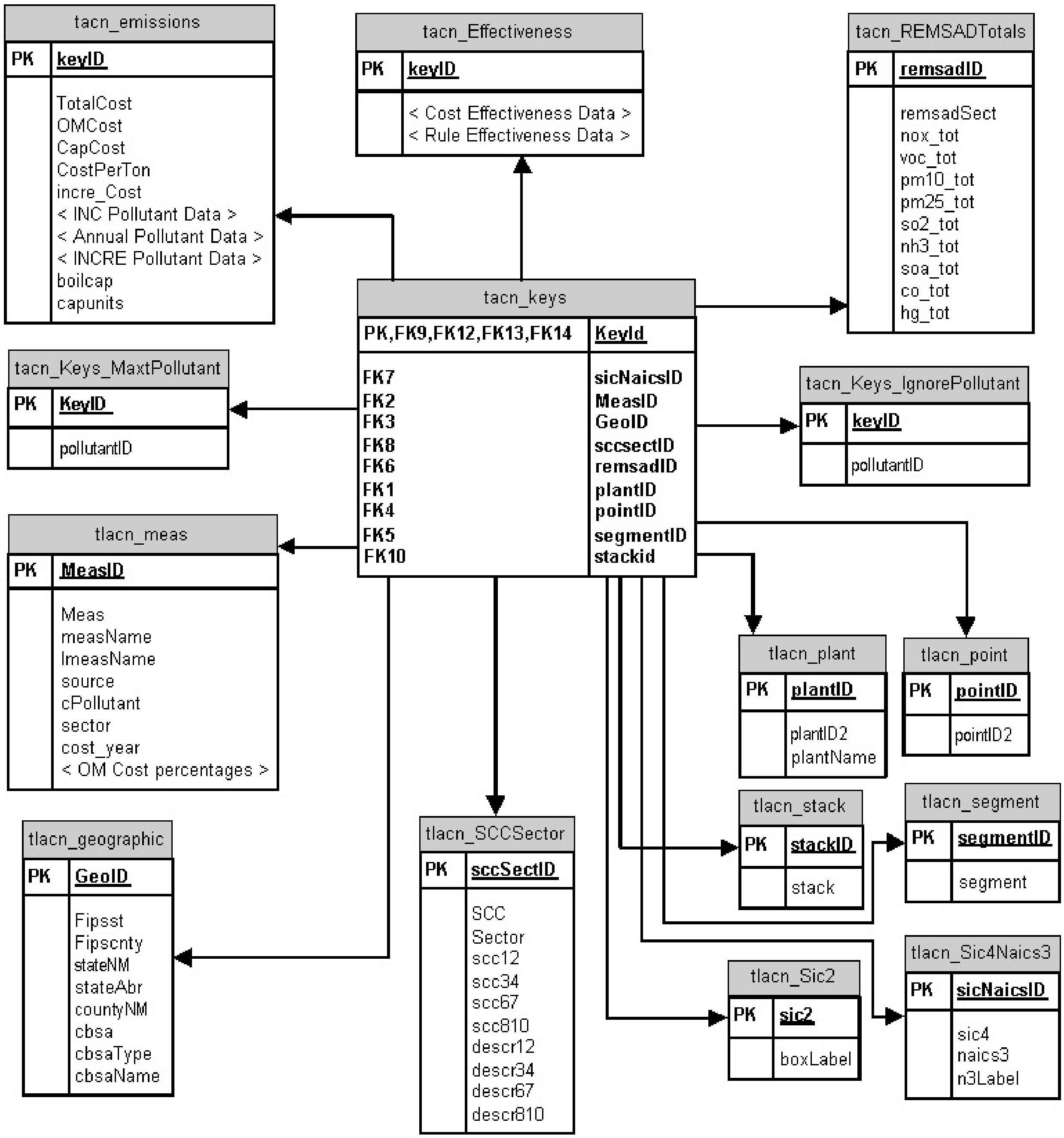


Table II-1. Filenames and Description of the AirControlNET Input Data Files

FILE NAME	Description
tacn_Keys_<data set name>.DBF	Main key table. Links to all data set tables.
tacn_Keys_<data set name>.CDX	Key index file.
tacn_Emissions_<data set name>.DBF	Emission and cost table.
tacn_Emissions_<data set name>.CDX	Emission and cost index file.
tacn_Effectiveness_<data set name>.DBF	Control Efficiency and Rule Effectiveness table.
tacn_Keys_IgnorePollutant_<data set name>.DBF	Indicates which keys should be ignored.
tacn_Keys_MaxtPollutant_<data set name>.DBF	Indicates which keys are Maxt rows.
tacn_Keys_RemsadTotals_<data set name>.DBF	REMSAD Totals for each key.
tlacn_geographic_<data set name>.DBF	Geographic lookup table. Contains State, county, and msa information.
tlacn_meas_<data set name>.DBF	Measure lookup table.
tlacn_SCCSector_<data set name>.DBF	SCC and Sector lookup table.
tlacn_sic2_<data set name>.DBF	Sic2 lookup table.
tlacn_sic4naics3_<data set name>.DBF	Sic4 and Naics3 lookup table.
tlacn_plant_<data set name>.DBF	Plant lookup table.
tlacn_point_<data set name>.DBF	Point lookup table.
tlacn_stack_<data set name>.DBF	Stack lookup table.
tlacn_segment_<data set name>.DBF	Segment lookup table.

Figure II-3. Data Relationships of the Tables listed in Table II-1



- adds four fields for each pollutant:
  - incremental pollutant
  - percent reduction pollutant
  - delete pollutant flag
  - maximum pollutant flag.

(NOTE: The values of these additional fields are also determined within this program. The delete pollutant flag indicates whether or not the controls make sense in terms of cost-effectiveness criteria (i.e., it flags control/source records if they cost more than other controls which give higher emissions reductions.)

- calculates the maximum control values, percent emissions reductions, incremental costs and emissions reductions.

The program acn_CreateDSFromMeasall.prg:

- takes the modified version of meas_all_<year> database that results from the first step as an input.

- removes records with total emissions of less than 0.1 tons (over all the pollutants)
- reformats certain fields
- optimizes the flat file by splitting it into the 16 data set files.

- the pollutant value fields are changed to contain three characters instead of one (e.g., NOX instead of N)

- the following data fields are added:
  - measure name
  - measure description
  - source name
  - North American Industry Classification System (NAICS) code
  - NAICS description
  - regional flag fields
  - Regulatory Modeling System for Aerosols and Deposition (REMSAD) sector key
  - REMSAD key.[1]

The regional flag fields include the following:

MSA - This field lists the Metropolitan Statistical Areas (MSAs). The MSA field includes metropolitan and consolidated areas. Further information on MSA definitions can be obtained from the U.S. Census Bureau website at http://www.census.gov/population/www/estimates/metroarea.html.

[1] The REMSAD sector key and key are required for the development of a Control Factor File which serves as the required input to the REMSAD-ST air quality model. The REMSAD sector key indicates either an Area (A) or Point (P) source. The REMSAD key is a character identifier containing FIPS State, FIPS County, 5 characters of Plant ID (for point sources), and SCC. Please refer to the AirControlNET User Manual for more details on the development of input scripts for use in REMSAD-ST.

WRAP - Western Regional Air Partnership (http://www.wrapair.org)

WESTAR - Western States Air Resources Council (http://www.westar.org)

LADCO - Lake Michigan Air Directors Consortium (http://www.ladco.org)
NESCAUM - Northeast States for Coordinated Air Use Management (http://www.nescaum.org)

MARAMA - Mid-Atlantic Regional Air Management Association (http://www.marama.org)

OTC - Ozone Transport Commission (http://www.otcair.org)

CENSARA - Central States Air Resource Agencies (http://www.censara.org)

SESARM - Southeastern States Air Resource Managers, Inc. (http://www.metro4-sesarm.org/sesarm.asp)

SAMI - Southern Appalachian Mountains Initiative (http://www.tva.gov/sami/)

NERC - North American Electric Reliability Council (http://www.nerc.com)

F. CALCULATION EXAMPLE

The core of AirControlNET is a relational database system developed in Visual FoxPro version 7.0 in which control measures are linked to emission sources provided in EPA emissions inventories. The system also contains a database of control measure applicability, efficiency, and cost information for reducing the emissions of criteria pollutants (e.g., NO_x, SO_2, VOC, PM, PM with organic carbon and elemental carbon components) as well as NH_3, CO, and Hg from point (utility and non-utility), area/nonroad, and onroad mobile sources.

The control measure information was obtained by examining the technical and cost data from EPA reports and other literature sources. In addition to the various reports, all the control measure information is outlined in a 2005 report called the AirControlNET Volume III: AirControlNET, Version 4.1, Control Measure Documentation Report (Pechan, 2006). Many of the costs for the controls were derived using information from the EPA Control Cost Manual (EPA, 2002b).

These controls are assigned to specific sources (i.e., plant/point/segment) using SCC as the key. In AirControlNET, control measure applicability information are organized and linked by Cost POD. A Cost POD is a group of source types, as defined by SCCs, which have similar emission characteristics, control techniques, and control costs. A Cost POD may have one or several control strategies (which consist of control options, efficiency, and cost information). All of the emission reduction and control cost calculations are performed at the Cost POD level. The Cost POD is used to link the control applicability information through the POD/SCC Crosswalk.

The control measure data file in AirControlNET includes not only the control efficiency and calculated emission reductions as applied for a particular source, but also estimates the annual and capital costs for application of the control measure to that specific source.

AirControlNET relies on the control efficiency, throughput, fuel use, and emission factor data provided in the EPA NEI format to perform cost-related analysis. The control data is accessed through a Cost POD, which is linked to sources by SCC, as described in Appendix A of the AirControlNET Documentation Report (Pechan, 2006).

In the least-cost module, when multiple controls are applied to the same source (i.e., plant/point/segment), incremental calculations are performed as described below.

The first step for least cost calculation is to sort all applicable controls in increasing order of $/ton number. They are sorted on an incremental cost $ per incremental reduction basis.

Consider following filtering criteria for least cost module query:

Inventory year:	1999
Cost Year:	1999
Pollutant:	NO_x
% Reduction:	100
State:	North Caroline (37)
County:	Chatham Co. (37037)
Sector:	All utility & nonutility points

Consider following boiler as an example:

Plant:	CP&L CAPE FEAR PLANT
Plantid:	0063
Pointid:	6

Annual emissions from the boiler are 3086.3 tons

Applicable controls for the boiler are as follows:

1. Combustion Optimization (CE = 20%) (In Figure II-4, Record No: 2)
2. LNC1 (CE = 33.1%) (In Figure II-4, Record No: 3)
3. LNC3 (CE = 53.1%) (In Figure II-4, Record No: 4)
4. SCR (CE = 90%) (In Figure II-4, Record No: 9)

Incremental reduction for Combustion Optimization (CE = 20%) is calculated as follows:
Incremental reduction for Combustion Optimization = 3086.3 x 0.2 = 617.3 tons
Total Reduction = 617.3 tons

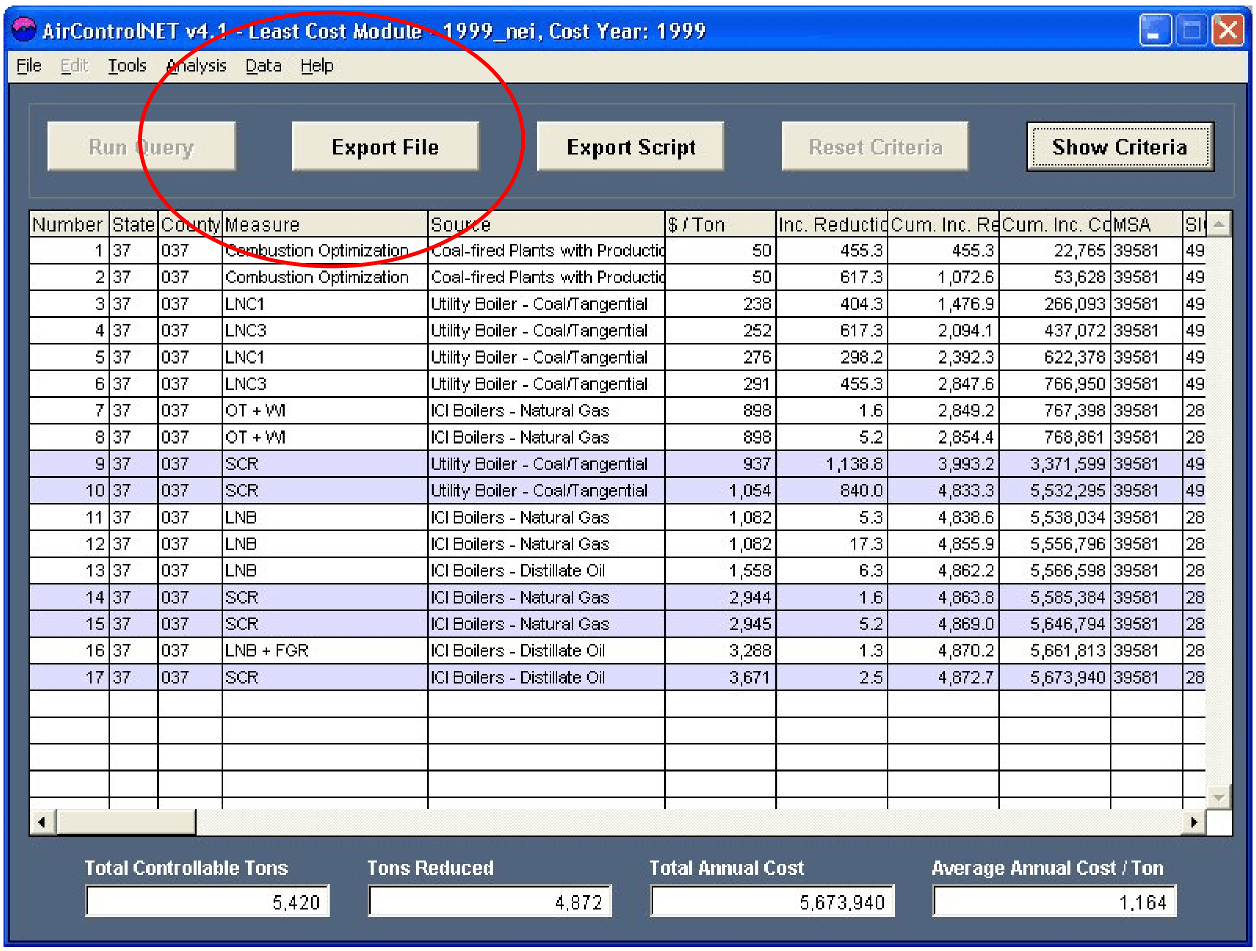
Incremental reduction for LNC1 (CE = 33.1%) is calculated as follows:
Incremental reduction for LNC1 = 3086.3 x 0.331- 617.3 = 404.3 tons

Total reduction = 1021.6 tons

Incremental reduction for LNC3 (CE - 53.1%) is calculated as follows:
Incremental reduction from LNC3 = 3086.3 x 0.531 - 1021.6 = 617.3 tons
Total reduction = 1638.9 tons

Incremental reduction for SCR (CE - 90%) is calculated as follows:
Incremental reduction from SCR = 3086.3 x 0.9 - 1638.9 = 1138.8 tons
Total reduction = 2777.7 tons

Figure II-4. Example Incremental Calculation for Least Cost Module



Number	State	County	Measure	Source	$ / Ton	Inc. Reductio	Cum. Inc. Re	Cum. Inc. Co	MSA	SI
1	37	037	Combustion Optimization	Coal-fired Plants with Productic	50	455.3	455.3	22,765	39581	49
2	37	037	Combustion Optimization	Coal-fired Plants with Productic	50	617.3	1,072.6	53,628	39581	49
3	37	037	LNC1	Utility Boiler - Coal/Tangential	238	404.3	1,476.9	266,093	39581	49
4	37	037	LNC3	Utility Boiler - Coal/Tangential	252	617.3	2,094.1	437,072	39581	49
5	37	037	LNC1	Utility Boiler - Coal/Tangential	276	298.2	2,392.3	622,378	39581	49
6	37	037	LNC3	Utility Boiler - Coal/Tangential	291	455.3	2,847.6	766,950	39581	49
7	37	037	OT + WI	ICI Boilers - Natural Gas	898	1.6	2,849.2	767,398	39581	28
8	37	037	OT + WI	ICI Boilers - Natural Gas	898	5.2	2,854.4	768,861	39581	28
9	37	037	SCR	Utility Boiler - Coal/Tangential	937	1,138.8	3,993.2	3,371,599	39581	49
10	37	037	SCR	Utility Boiler - Coal/Tangential	1,054	840.0	4,833.3	5,532,295	39581	49
11	37	037	LNB	ICI Boilers - Natural Gas	1,082	5.3	4,838.6	5,538,034	39581	28
12	37	037	LNB	ICI Boilers - Natural Gas	1,082	17.3	4,855.9	5,556,796	39581	28
13	37	037	LNB	ICI Boilers - Distillate Oil	1,558	6.3	4,862.2	5,566,598	39581	28
14	37	037	SCR	ICI Boilers - Natural Gas	2,944	1.6	4,863.8	5,585,384	39581	28
15	37	037	SCR	ICI Boilers - Natural Gas	2,945	5.2	4,869.0	5,646,794	39581	28
16	37	037	LNB + FGR	ICI Boilers - Distillate Oil	3,288	1.3	4,870.2	5,661,813	39581	28
17	37	037	SCR	ICI Boilers - Distillate Oil	3,671	2.5	4,872.7	5,673,940	39581	28

So if SCR control is required to reach to target reduction, the incremental reduction (1138.8 tons) from SCR is added to cumulative reduction and total reduction for SCR is 2777.7 tons and selected control will be SCR.

The most stringent control applied to a source is the actual control for the source. The output results of Least Cost Module give maximum applicable controls for a source required to reach to specified reduction target on least cost basis. In the Least Cost Module database grid, maximum controls for the source are highlighted.

In the least cost module, cost calculation is done in similar way as reduction. As the control gets selected by the Least Cost Module, its incremental cost is added to the cumulative cost and total cumulative cost to calculate the cost of controls to achieve the desired reductions. An average cost per ton is the ratio of total cost and total reduction.

In the above example, cost of Combustion Optimization control measure was calculated using cost information of $50 / ton of pollutant reduced. Cost of LNC1, LNC3 and SCR control measures was calculated using cost equations as described in Pechan, 2006. These cost equations and input variables are listed below. Table II-2 provides the input parameters used in the cost equations. These can be found for each control measure can also be found in At-A-Glance tables for the Source Category: Utility Boiler - Coal/Tangential in Pechan's 2006 report called the AirControlNET Volume III: AirControlNET Control Measure Documentation Report (see Pechan, 2006).

Cost Equations Inputs:

Nameplate Capacity: netdc in MW
Total Capital Cost: TCC in $ per KW
Scaling Factor Numerator: sfn in MW
Scaling Factor Exponential: sfe
Scaling Factor (SF) = (sfn / netdc)^sfe

Capital Cost:

Capital Cost (CC) (For netdc < Threshold Capacity in MW) = TCC * netdc * 1000 * SF
Capital Cost (CC) (For netdc > Threshold Capacity in MW) = TCC * netdc * 1000

Operating & Maintenance (O&M):

Fixed O&M: omf in $ per KW per year
Variable O&M: omv in $ mills per KW-hr
Capacity Factor: capfac

O&M = (omf * netdc * 1000) + (omv * netdc * 1000 * capfac * 8760 / 1000)

Equipment Life: Equiplife in years
interest rate: I in %

Capital Recovery Factor: CRF = [i * (1 +i) ^Equiplife] / [((1 + i)^Equiplife) - 1]

Total Cost = (CRF * CC) + O&M

Table II-2 Cost Equations Inputs for Each Example Control Measures

Parameter	LNC1	LNC3	SCR
omf ($ per KW per year)	0.14	0.22	0.66
omv (mills per KW-hr)	0	0.02	0.6
sfn	300	300	243
sfe	0.359	0.359	0.270
capfac	0.85	0.85	0.65
Equipment Life (years)	15	15	20
TCC	9.1	14.5	100
Threshold Capacity	500	500	600

For Combustion Optimization:
Total Annualized Cost = Tons Reduced * Cost per ton = 617.3 tons * $50 / ton = $30,863

Netdc of the example boiler = 182.298 MW
Interest Rate = 7%

For SCR:
Total Capital Cost = $ 100 /KW
Scaling Factor: SF = (243 / 182.298) ^0.27 = 1.081

Capital Cost (for netdc < 600 MW)
CC = TCC * netdc * 1000 * SF
= 100 * 182.298 * 1000 * 1.081
= $19,700,828

Operating & Maintenance (O&M) Cost:
O&M Cost = (omf * netdc * 1000) + (omv * netdc * 1000 * capfac * 8760 / 1000)
= (0.66 * 182.298 * 1000) + (0.6 * 182.298 * 1000 * 0.65 * 8760 / 1000)
= $ 743,119

Capital Recovery Factor:
CRF = [i * (1 + i)^Equiplife] / [((1 + i)^Equiplife) - 1]
= [0.07 * (1 + 0.07)^20] / [((1 + 0.07)^20) - 1]
= 0.094393

Total Annual Cost:
= (CRF * CC) + O&M
= (0.09439 * 19,700,828) + 743,119
= $2,602,738

Similarly for LNC1 & LNC3:

LNC1:
Scaling Factor: SF = (300 / 182.298) ^0.359 = 1.1958
Capital Cost: CC = 9.1 * 182.298 * 1000 * 1.1958 = $1,983,760
O&M Cost: O&M = 0.14 * 182.298 * 1000 + (0 * 182.298 * 1000 * 0.85 * 8760 / 1000)
= $25,522
Capital Recovery Factor: CRF = [0.07 * (1 + 0.07)^15] / [((1 + 0.07)^15) - 1] = 0.10979
Total Annual Cost: TC = $1,983,760 * 0.10979 + $25,522 = $ 243,319

LNC3:
Scaling Factor: SF = (300 / 182.298) ^0.359 = 1.1958
Capital Cost: CC = 14.5 * 182.298 * 1000 * 1.1958 = $3,160,883
O&M Cost: O&M = 0.22 * 182.298 * 1000 + (0.02 * 182.298 * 1000 * 0.85 * 8760 / 1000)
= $67,253
Capital Recovery Factor: CRF = [0.07 * (1 + 0.07)^15] / [((1 + 0.07)^15) - 1] = 0.10979
Total Annual Cost: TC = $3,160,883 * 0.10979 + $67,253 = $ 414,307

The control measure data file in AirControlNET includes not only the control efficiency and calculated emission reductions as applied for a particular source, but also estimates the annual and capital costs for application of the control measure to that specific source.

AirControlNET relies on the control efficiency, throughput, fuel use, and emission factor data provided in the EPA NEI format to perform cost-related analysis. As indicated in Table III-1, AirControlNET currently contains information on several hundred different control measure/source combinations. The control data is accessed as described in Appendix A of the AirControlNET Documentation Report (Pechan, 2006).

Total Controllable Tons:

In Least Cost Module, total controllable tons are defined as the sum of emissions from sources (i.e., plant/point/segment) that have been controlled within AirControlNET and selected for the specified query criteria.

For 1999 emissions inventory, nationwide total controllable tons for each pollutant by sector are listed in Table II-3.

Table II-3. 1999 Nationwide Emissions by Pollutant and Sector

	Area		Onroad		Point	
Pollutant	Uncontrolled Emissions	Controlled Emissions	Uncontrolled Emissions	Controlled Emissions	Uncontrolled Emissions	Controlled Emissions
VOC	10,812,750	5,459,791	5,564,026	5,564,026	2,061,167	99,820
NO_x	7,767,324	4,425,712	8,470,270	8,470,270	9,037,572	6,579,473
SO2	2,226,341	192,671	322,189	322,189	16,297,280	1,668,378
PM	5,869,957	4,557,568	188,328	188,328	673,288	310,873
NH3	4,507,679	3,518,580	265,533	265,533	195,345	0

Consider following filtering criteria as an example for Least Cost Module query:

State:	North Carolina (37)
County:	Chatham Co. (37037)
Pollutant:	NO_x
Cost per ton:	All
Target Reductions:	100%
Sector:	All Point sources (i.e., EGUs and NEGUs)
Cost Year:	1999
Inventory year:	1999

Following control summary results are obtained for the query.

Total Controllable Tons = 5,420 tons
Tons Reduced = 4,870 tons

When Percentage Reduction target is defined to say 50 percent, target reduction is calculated to 50 percent of total available reductions (i.e., 4,870 tons). So reduction target in absolute tons would be 2,436 tons. Due to the discrete nature of control reductions, tons reduced would be equal to or greater than 2,436 tons. Actual reductions achieved for 50 percent target reduction are 2,847 tons.

The most stringent control applied to a source is the actual control for the source. The output results of Least Cost Module give maximum applicable controls for a source required to reach to specified reduction target on least cost basis. Most stringent controls for the sources selected by least cost query are highlighted in the database grid. Only maximum control applied to the source (i.e., plant/point/segment) is exported to the output file.

CHAPTER III
AirControlNET CONTROL MEASURE CONTENT SUMMARIES

Since 1997, information for each control measure has been collected and reported to EPA through separate reports. Important aspects of each control measure, such as application, functionality, cost and control efficiencies were reported at the time of analysis. In addition to the various reports, detailed control measure information is provided in a 2006 report called the AirControlNET Volume III: AirControlNET Control Measure Documentation Report (Pechan, 2006).

A list of the control measures, by major pollutant and source category, currently in AirControlNET is provided in Table III-1. Further details of the control measures are provided in Appendix B, including other affected pollutants, control efficiency and cost effectiveness.

Table III-1. Control Measures Currently in AirControlNET

Source Category	Major Pollutant	Control Measure	Other Pollutant
AREA	VOC	OTC Consumer Products Rule	
AREA	VOC	OTC MER Rule	
AREA	VOC	OTC Solvent Cleaning Rule	
Adhesives - Industrial	VOC	SCAQMD Rule 1168	
Agricultural Burning	NOX	Seasonal Ban (Ozone Season Daily)	
Agricultural Burning	PM	Bale Stack/Propane Burning	OC, EC, PM25
Agricultural Tilling	PM	Soil Conservation Plans	OC, EC, PM25, PM10
Aircraft Surface Coating	VOC	MACT	
Ammonia - Natural Gas - Fired Reformers - Small Sources	NOX	LNB	
Ammonia - Natural Gas - Fired Reformers - Small Sources	NOX	LNB + FGR	
Ammonia - Natural Gas - Fired Reformers - Small Sources	NOX	OT + WI	
Ammonia - Natural Gas - Fired Reformers - Small Sources	NOX	SCR	NH3
Ammonia - Natural Gas - Fired Reformers - Small Sources	NOX	SNCR	NH3
Ammonia Products; Feedstock Desulfurization - Small Sources	NOX	LNB + FGR	
Architectural Coatings	VOC	AIM Coating Federal Rule	
Architectural Coatings	VOC	OTC AIM Coating Rule	
Architectural Coatings	VOC	South Coast Phase I	
Architectural Coatings	VOC	South Coast Phase II	
Architectural Coatings	VOC	South Coast Phase III	
Asphalt Manufacture	PM	CEM Upgrade and Increased Monitoring Frequency of	
Asphalt Manufacture	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Asphalt Manufacture	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Asphalt Manufacture	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Asphalt Manufacture	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Asphalt Manufacture	PM	Paper/Nonwoven Filters - Cartridge Collector Type	OC, EC, PM25
Asphaltic Conc; Rotary Dryer; Conv Plant - Small Sources	NOX	LNB	
Automobile Refinishing	VOC	CARB BARCT Limits	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Automobile Refinishing	VOC	FIP Rule (VOC content & TE)	
Automobile Refinishing	VOC	Federal Rule	
Bakery Products	VOC	Incineration >100,000 lbs bread	
Beef Cattle Feedlots	PM	Watering	OC, EC, PM25
Bituminous/Subbituminous Coal (Industrial Boilers)	SO2	IDIS	
Bituminous/Subbituminous Coal (Industrial Boilers)	SO2	SDA	
Bituminous/Subbituminous Coal (Industrial Boilers)	SO2	Wet FGD	
Bituminous/Subbituminous Coal	SO2	FGD	
By-Product Coke Manufacturing; Oven Underfiring	NOX	SNCR	NH3
By-Product Coke Manufacturing	SO2	Vacuum Carbonate Plus Sulfur Recovery Plant	
Cattle Feedlots	NH3	Chemical Additives to Waste	
Cement Kilns	NOX	Biosolid Injection	
Cement Manufacturing - Dry	NOX	LNB	
Cement Manufacturing - Dry	NOX	Mid-Kiln Firing	
Cement Manufacturing - Dry	NOX	SCR	NH3
Cement Manufacturing - Dry	NOX	SNCR - NH3 Based	NH3
Cement Manufacturing - Dry	NOX	SNCR - Urea Based	NH3
Cement Manufacturing - Wet - Large Sources	NOX	SCR	NH3
Cement Manufacturing - Wet - Small Sources	NOX	SCR	NH3
Cement Manufacturing - Wet	NOX	LNB	
Cement Manufacturing - Wet	NOX	Mid-Kiln Firing	
Ceramic Clay Manufacturing; Drying - Small Sources	NOX	LNB	
Chemical Manufacture	PM	CEM Upgrade and Increased Monitoring Frequency of	
Chemical Manufacture	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Chemical Manufacture	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Coal Cleaning-Thrml Dryer; Fluidized Bed - Small Sources	NOX	LNB	
Coal-fired Plants with Production Capacities>100MW	NOX	Combustion Optimization	
Combustion Turbines - Jet Fuel - Small Sources	NOX	SCR + Water Injection	
Combustion Turbines - Jet Fuel - Small Sources	NOX	Water Injection	
Combustion Turbines - Natural Gas - Large Sources	NOX	LNB	
Combustion Turbines - Natural Gas - Small Sources	NOX	LNB	
Combustion Turbines - Natural Gas - Small Sources	NOX	SCR + LNB	NH3

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Combustion Turbines - Natural Gas - Small Sources	NOX	SCR + Steam Injection	NH3
Combustion Turbines - Natural Gas - Small Sources	NOX	SCR + Water Injection	
Combustion Turbines - Natural Gas - Small Sources	NOX	Steam Injection	
Combustion Turbines - Natural Gas - Small Sources	NOX	Water Injection	
Combustion Turbines - Oil - Small Sources	NOX	SCR + Water Injection	
Combustion Turbines - Oil - Small Sources	NOX	Water Injection	
Commercial Adhesives	VOC	CARB Long-Term Limits	
Commercial Adhesives	VOC	CARB Mid-Term Limits	
Commercial Adhesives	VOC	Federal Consumer Solvents Rule	
Commercial Institutional Boilers - Coal	PM	CEM Upgrade and Increased Monitoring Frequency of	
Commercial Institutional Boilers - Coal	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Commercial Institutional Boilers - Coal	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Commercial Institutional Boilers - Coal	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Commercial Institutional Boilers - Coal	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Commercial Institutional Boilers - Natural Gas	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Commercial Institutional Boilers - Oil	PM	CEM Upgrade and Increased Monitoring Frequency of	
Commercial Institutional Boilers - Oil	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Commercial Institutional Boilers - Oil	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Commercial Institutional Boilers - Solid Waste	PM	CEM Upgrade and Increased Monitoring Frequency of	
Commercial Institutional Boilers - Solid Waste	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Commercial Institutional Boilers - Wood/Bark	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Commercial Institutional Boilers - Wood/Bark	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Commercial Institutional Boilers - Wood/Bark	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Commercial Institutional Boilers - Wood	PM	CEM Upgrade and Increased Monitoring Frequency of	
Commercial Institutional Boilers - Wood	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Commercial/Institutional - Natural Gas	NOX	Water Heater + LNB Space Heaters	
Commercial/Institutional - Natural Gas	NOX	Water Heater Replacement	
Commercial/Institutional Incinerators	NOX	SNCR	NH3
Construction Activities	PM	Dust Control Plan	OC, EC, PM25
Consumer Solvents	VOC	CARB Long-Term Limits	
Consumer Solvents	VOC	CARB Mid-Term Limits	
Consumer Solvents	VOC	Federal Consumer Solvents Rule	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Conv Coating of Prod; Acid Cleaning Bath - Small Sources	NOX	LNB	
Conveyorized Charbroilers	PM	Catalytic Oxidizer	VOC, OC, EC
Conveyorized Charbroilers	PM	ESP for Commercial Cooking	OC, EC
Cutback Asphalt	VOC	Switch to Emulsified Asphalts	
Diesel Locomotives	NOX	SCR	
Electric Generation - Coke	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - Coke	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electric Generation - Bagasse	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - Bagasse	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electric Generation - Coal	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - Coal	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electric Generation - Coal	PM	Indigo Agglomerator	OC, EC, PM10
Electric Generation - Coal	PM	One plate ESP upgrade	OC, EC, PM10
Electric Generation - Coal	PM	Two plate ESP upgrade	OC, EC, PM10
Electric Generation - LPG	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - LPG	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electric Generation - Liquid Waste	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - Liquid Waste	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electric Generation - Natural Gas	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - Natural Gas	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electric Generation - Oil	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - Oil	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electric Generation - Solid Waste	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - Solid Waste	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electric Generation - Wood	PM	CEM Upgrade and Increased Monitoring Frequency of	
Electric Generation - Wood	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Electrical/Electronic Coating	VOC	MACT	
Electrical/Electronic Coating	VOC	SCAQMD Rule	
Fabric Printing, Coating and Dyeing	VOC	Permanent Total Enclosure (PTE)	
Fabricated Metal Products - Abrasive Blasting	PM	Paper/Nonwoven Filters - Cartridge Collector Type	OC, EC, PM25
Fabricated Metal Products - Welding	PM	Paper/Nonwoven Filters - Cartridge Collector Type	OC, EC, PM25
Ferrous Metals Processing - Coke	PM	CEM Upgrade and Increased Monitoring Frequency of	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Ferrous Metals Processing - Coke	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Ferrous Metals Processing - Coke	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Ferrous Metals Processing - Coke	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Ferrous Metals Processing - Coke	PM	Venturi Scrubber	OC, EC, PM25
Ferrous Metals Processing - Ferroalloy Production	PM	CEM Upgrade and Increased Monitoring Frequency of	
Ferrous Metals Processing - Ferroalloy Production	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Ferrous Metals Processing - Ferroalloy Production	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Ferrous Metals Processing - Ferroalloy Production	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Ferrous Metals Processing - Ferroalloy Production	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Ferrous Metals Processing - Gray Iron Foundries	PM	CEM Upgrade and Increased Monitoring Frequency of	
Ferrous Metals Processing - Gray Iron Foundries	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Ferrous Metals Processing - Gray Iron Foundries	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Ferrous Metals Processing - Gray Iron Foundries	PM	Impingement-Plate Scrubber	OC, EC, PM25
Ferrous Metals Processing - Gray Iron Foundries	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Ferrous Metals Processing - Gray Iron Foundries	PM	Venturi Scrubber	OC, EC, PM25
Ferrous Metals Processing - Iron & Steel Production	PM	CEM Upgrade and Increased Monitoring Frequency of	
Ferrous Metals Processing - Iron & Steel Production	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Ferrous Metals Processing - Iron and Steel Production	PM	Capture Hood Vented to a Baghouse	OC, EC, PM10
Ferrous Metals Processing - Iron and Steel Production	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Ferrous Metals Processing - Iron and Steel Production	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Ferrous Metals Processing - Iron and Steel Production	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Ferrous Metals Processing - Iron and Steel Production	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Ferrous Metals Processing - Iron and Steel Production	PM	Secondary Capture and Control System	OC, EC, PM10
Ferrous Metals Processing - Iron and Steel Production	PM	Sinter Cooler	OC, EC, PM10
Ferrous Metals Processing - Iron and Steel Production	PM	Venturi Scrubber	OC, EC, PM25
Ferrous Metals Processing - Iron and Steel Production	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Ferrous Metals Processing - Other	PM	CEM Upgrade and Increased Monitoring Frequency of	
Ferrous Metals Processing - Other	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Ferrous Metals Processing - Steel Foundries	PM	CEM Upgrade and Increased Monitoring Frequency of	
Ferrous Metals Processing - Steel Foundries	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Ferrous Metals Processing - Steel Foundries	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Ferrous Metals Processing - Steel Foundries	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Ferrous Metals Processing - Steel Foundries	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Ferrous Metals Processing - Steel Foundries	PM	Venturi Scrubber	OC, EC, PM25
Fiberglass Manufacture; Textile-Type; Recuperative Furnaces	NOX	LNB	
Flexographic Printing	VOC	Permanent Total Enclosure (PTE)	
Fluid Catalytic Cracking Units - Small Sources	NOX	LNB + FGR	
Fuel Fired Equipment - Process Heaters	NOX	LNB + FGR	
Fuel Fired Equipment; Furnaces; Natural Gas	NOX	LNB	
Glass Manufacturing - Containers	NOX	Cullet Preheat	
Glass Manufacturing - Containers	NOX	Electric Boost	
Glass Manufacturing - Containers	NOX	LNB	
Glass Manufacturing - Containers	NOX	OXY-Firing	
Glass Manufacturing - Containers	NOX	SCR	NH3
Glass Manufacturing - Containers	NOX	SNCR	NH3
Glass Manufacturing - Flat - Large Sources	NOX	SCR	NH3
Glass Manufacturing - Flat - Large Sources	NOX	SNCR	NH3
Glass Manufacturing - Flat - Small Sources	NOX	SCR	NH3
Glass Manufacturing - Flat - Small Sources	NOX	SNCR	NH3
Glass Manufacturing - Flat	NOX	Electric Boost	
Glass Manufacturing - Flat	NOX	LNB	
Glass Manufacturing - Flat	NOX	OXY-Firing	
Glass Manufacturing - Pressed	NOX	Cullet Preheat	
Glass Manufacturing - Pressed	NOX	Electric Boost	
Glass Manufacturing - Pressed	NOX	LNB	
Glass Manufacturing - Pressed	NOX	OXY-Firing	
Glass Manufacturing - Pressed	NOX	SCR	NH3
Glass Manufacturing - Pressed	NOX	SNCR	NH3
Grain Milling	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Grain Milling	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Grain Milling	PM	Paper/Nonwoven Filters - Cartridge Collector Type	OC, EC, PM25
Graphic Arts	VOC	Use of Low or No VOC Materials	
Highway Vehicles - Gasoline Engine	NOX	Transportation Control Package	CO, NOX
Highway Vehicles - Gasoline Engine	PM	HDDV Retrofit Program	CO, NOX
Highway Vehicles - Gasoline Engine	VOC	Federal Reformulated Gasoline	CO, NOX

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Highway Vehicles - Heavy Duty Diesel Engines	NOX		CO, SO2, VOC, PM25, PM10
Highway Vehicles - Heavy Duty Diesel Engines	PM		CO, SO2, VOC, PM25
Highway Vehicles - Heavy Duty and Diesel-Fueled Vehicles	NOX		CO, SO2, VOC, PM25, PM10
Highway Vehicles - Light Duty Gasoline Engines	NOX	Enhanced I/M	CO, VOC
Highway Vehicles - Light Duty Gasoline Engines	VOC	Basic I&M	CO, NH3, SO2, NOX, PM25, PM10
Highway Vehicles - Light Duty and Gasoline-Fueled Vehicles	NOX		CO, SO2, VOC, PM25, PM10
Hog Operations	NH3	Chemical Additives to Waste	
IC Engines - Gas - Small Sources	NOX	SCR	
IC Engines - Gas, Diesel, LPG - Small Sources	NOX	IR	
IC Engines - Gas, Diesel, LPG - Small Sources	NOX	SCR	
IC Engines - Gas	NOX	L-E (Low Speed)	
ICI Boilers - Coal/Cyclone - Large Sources	NOX	Coal Reburn	
ICI Boilers - Coal/Cyclone - Small Sources	NOX	Coal Reburn	
ICI Boilers - Coal/Cyclone - Small Sources	NOX	NGR	
ICI Boilers - Coal/Cyclone - Small Sources	NOX	SCR	
ICI Boilers - Coal/Cyclone - Small Sources	NOX	SNCR	NH3
ICI Boilers - Coal/FBC - Large Sources	NOX	SNCR - Urea Based	NH3
ICI Boilers - Coal/FBC - Small Sources	NOX	SNCR - Urea Based	NH3
ICI Boilers - Coal/Stoker - Small Sources	NOX	SNCR	NH3
ICI Boilers - Coal/Wall - Large Sources	NOX	LNB	
ICI Boilers - Coal/Wall - Large Sources	NOX	SCR	NH3
ICI Boilers - Coal/Wall - Large Sources	NOX	SNCR	NH3
ICI Boilers - Coal/Wall - Small Sources	NOX	LNB	
ICI Boilers - Coal/Wall - Small Sources	NOX	SCR	
ICI Boilers - Coal/Wall - Small Sources	NOX	SNCR	NH3
ICI Boilers - Coke - Small Sources	NOX	LNB	
ICI Boilers - Coke - Small Sources	NOX	SCR	NH3
ICI Boilers - Coke - Small Sources	NOX	SNCR	NH3
ICI Boilers - Distillate Oil - Large Sources	NOX	SNCR	NH3
ICI Boilers - Distillate Oil - Small Sources	NOX	LNB	
ICI Boilers - Distillate Oil - Small Sources	NOX	LNB + FGR	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
ICI Boilers - Distillate Oil - Small Sources	NOX	SCR	NH3
ICI Boilers - Distillate Oil - Small Sources	NOX	SNCR	NH3
ICI Boilers - LPG - Small Sources	NOX	LNB	
ICI Boilers - LPG - Small Sources	NOX	LNB + FGR	
ICI Boilers - LPG - Small Sources	NOX	SCR	NH3
ICI Boilers - LPG - Small Sources	NOX	SNCR	NH3
ICI Boilers - Liquid Waste - Small Sources	NOX	LNB	
ICI Boilers - Liquid Waste - Small Sources	NOX	LNB + FGR	
ICI Boilers - Liquid Waste - Small Sources	NOX	SNCR	NH3
ICI Boilers - Liquid Waste	NOX	SCR	NH3
ICI Boilers - MSW/Stoker - Small Sources	NOX	SNCR - Urea	NH3
ICI Boilers - Natural Gas - Large Sources	NOX	SNCR	NH3
ICI Boilers - Natural Gas - Small Sources	NOX	LNB	
ICI Boilers - Natural Gas - Small Sources	NOX	LNB + FGR	
ICI Boilers - Natural Gas - Small Sources	NOX	OT + WI	
ICI Boilers - Natural Gas - Small Sources	NOX	SCR	NH3
ICI Boilers - Natural Gas - Small Sources	NOX	SNCR	NH3
ICI Boilers - Process Gas - Small Sources	NOX	LNB	
ICI Boilers - Process Gas - Small Sources	NOX	LNB + FGR	
ICI Boilers - Process Gas - Small Sources	NOX	OT + WI	
ICI Boilers - Process Gas - Small Sources	NOX	SCR	NH3
ICI Boilers - Residual Oil - Large Sources	NOX	SNCR	NH3
ICI Boilers - Residual Oil - Small Sources	NOX	LNB	
ICI Boilers - Residual Oil - Small Sources	NOX	LNB + FGR	
ICI Boilers - Residual Oil - Small Sources	NOX	SCR	NH3
ICI Boilers - Residual Oil - Small Sources	NOX	SNCR	NH3
ICI Boilers - Wood/Bark/Stoker - Large Sources	NOX	SNCR - Urea Based	NH3
ICI Boilers - Wood/Bark/Stoker - Small Sources	NOX	SNCR - Urea	NH3
In-Proc; Process Gas; Coke Oven/Blast Ovens	NOX	LNB + FGR	
In-Process Fuel Use - Bituminous Coal - Small Sources	NOX	SNCR	NH3
In-Process Fuel Use; Natural Gas - Small Sources	NOX	LNB	
In-Process Fuel Use; Residual Oil - Small Sources	NOX	LNB	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
In-Process; Bituminous Coal; Cement Kilns	NOX	SNCR - Urea Based	NH3
In-Process; Bituminous Coal; Lime Kilns	NOX	SNCR - Urea Based	NH3
In-Process; Process Gas; Coke Oven Gas	NOX	LNB	
In-process Fuel Use - Bituminous Coal	SO2	FGD	
Industrial Boilers - Coal	PM	CEM Upgrade and Increased Monitoring Frequency of	
Industrial Boilers - Coal	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Industrial Boilers - Coal	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Industrial Boilers - Coal	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Industrial Boilers - Coal	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Industrial Boilers - Coal	PM	Venturi Scrubber	OC, EC, PM25
Industrial Boilers - Coke	PM	CEM Upgrade and Increased Monitoring Frequency of	
Industrial Boilers - Coke	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Industrial Boilers - Liquid Waste	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Industrial Boilers - Oil	PM	CEM Upgrade and Increased Monitoring Frequency of	
Industrial Boilers - Oil	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Industrial Boilers - Oil	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Industrial Boilers - Oil	PM	Venturi Scrubber	OC, EC, PM25
Industrial Boilers - Solid Waste	PM	CEM Upgrade and Increased Monitoring Frequency of	
Industrial Boilers - Solid Waste	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Industrial Boilers - Wood	PM	CEM Upgrade and Increased Monitoring Frequency of	
Industrial Boilers - Wood	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Industrial Boilers - Wood	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Industrial Boilers - Wood	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Industrial Boilers - Wood	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Industrial Boilers - Wood	PM	Venturi Scrubber	OC, EC, PM25
Industrial Coal Combustion	NOX	RACT to 25 tpy (LNB)	
Industrial Coal Combustion	NOX	RACT to 50 tpy (LNB)	
Industrial Incinerators	NOX	SNCR	NH3
Industrial Maintenance Coating	VOC	AIM Coating Federal Rule	
Industrial Maintenance Coating	VOC	South Coast Phase I	
Industrial Maintenance Coating	VOC	South Coast Phase II	
Industrial Maintenance Coating	VOC	South Coast Phase III	
Industrial Natural Gas Combustion	NOX	RACT to 25 tpy (LNB)	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Industrial Natural Gas Combustion	NOX	RACT to 50 tpy (LNB)	
Industrial Oil Combustion	NOX	RACT to 25 tpy (LNB)	
Industrial Oil Combustion	NOX	RACT to 50 tpy (LNB)	
Inorganic Chemical Manufacture Operations	SO2	FGD	
Internal Combustion Engines - Gas - Large Sources	NOX	AF + IR	
Internal Combustion Engines - Gas - Large Sources	NOX	AF RATIO	
Internal Combustion Engines - Gas - Large Sources	NOX	IR	
Internal Combustion Engines - Gas - Small Sources	NOX	AF + IR	
Internal Combustion Engines - Gas - Small Sources	NOX	AF RATIO	
Internal Combustion Engines - Gas - Small Sources	NOX	IR	
Internal Combustion Engines - Gas	NOX	L-E (Medium Speed)	
Internal Combustion Engines - Oil - Small Sources	NOX	IR	
Internal Combustion Engines - Oil - Small Sources	NOX	SCR	NH3
Iron & Steel Mills - Annealing - Small Sources	NOX	LNB + SCR	NH3
Iron & Steel Mills - Annealing - Small Sources	NOX	SCR	NH3
Iron & Steel Mills - Annealing	NOX	LNB	NH3
Iron & Steel Mills - Annealing	NOX	LNB + FGR	
Iron & Steel Mills - Annealing	NOX	LNB + SNCR	NH3
Iron & Steel Mills - Annealing	NOX	SNCR	NH3
Iron & Steel Mills - Galvanizing	NOX	LNB	
Iron & Steel Mills - Galvanizing	NOX	LNB + FGR	
Iron & Steel Mills - Reheating	NOX	LEA	
Iron & Steel Mills - Reheating	NOX	LNB	
Iron & Steel Mills - Reheating	NOX	LNB + FGR	
Iron Production; Blast Furnaces; Blast Heating Stoves	NOX	LNB + FGR	
Lignite (Industrial Boiler)	SO2	IDIS	
Lignite (Industrial Boiler)	SO2	SDA	
Lignite (Industrial Boiler)	SO2	Wet FGD	
Lignite (Industrial Boilers)	SO2	FGD	
Lime Kilns	NOX	LNB	
Lime Kilns	NOX	Mid-Kiln Firing	
Machinery, Equipment, and Railroad Coating	VOC	SCAQMD Limits	
Marine Surface Coating (Shipbuilding)	VOC	Add-On Controls	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Marine Surface Coating (Shipbuilding)	VOC	MACT	
Medical Waste Incinerators	NOX	SNCR	NH3
Metal Can Surface Coating Operations	VOC	Permanent Total Enclosure (PTE)	
Metal Coil & Can Coating	VOC	BAAQMD Rule 11 Amended	
Metal Coil & Can Coating	VOC	Incineration	
Metal Coil & Can Coating	VOC	MACT	
Metal Furniture Surface Coating Operations	VOC	Permanent Total Enclosure (PTE)	
Metal Furniture, Appliances, Parts	VOC	MACT	
Metal Furniture, Appliances, Parts	VOC	SCAQMD Limits	
Mineral Products - Cement Manufacture	PM	CEM Upgrade and Increased Monitoring Frequency of	
Mineral Products - Cement Manufacture	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Mineral Products - Cement Manufacture	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Mineral Products - Cement Manufacture	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Mineral Products - Cement Manufacture	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Mineral Products - Cement Manufacture	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Mineral Products - Cement Manufacture	PM	Paper/Nonwoven Filters - Cartridge Collector Type	OC, EC, PM25
Mineral Products - Coal Cleaning	PM	CEM Upgrade and Increased Monitoring Frequency of	
Mineral Products - Coal Cleaning	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Mineral Products - Coal Cleaning	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Mineral Products - Coal Cleaning	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Mineral Products - Coal Cleaning	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Mineral Products - Coal Cleaning	PM	Paper/Nonwoven Filters - Cartridge Collector Type	OC, EC, PM25
Mineral Products - Coal Cleaning	PM	Venturi Scrubber	OC, EC, PM25
Mineral Products - Other	PM	CEM Upgrade and Increased Monitoring Frequency of	
Mineral Products - Other	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Mineral Products - Other	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Mineral Products - Other	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Mineral Products - Other	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Mineral Products - Other	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Mineral Products - Other	PM	Paper/Nonwoven Filters - Cartridge Collector Type	OC, EC, PM25
Mineral Products - Other	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Mineral Products - Stone Quarrying & Processing	PM	CEM Upgrade and Increased Monitoring Frequency of	
Mineral Products - Stone Quarrying & Processing	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Mineral Products - Stone Quarrying and Processing	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Mineral Products - Stone Quarrying and Processing	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Mineral Products - Stone Quarrying and Processing	PM	Fabric Filter (Pulse Jet Type)	OC, EC, PM25
Mineral Products - Stone Quarrying and Processing	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Mineral Products - Stone Quarrying and Processing	PM	Paper/Nonwoven Filters - Cartridge Collector Type	OC, EC, PM25
Mineral Products - Stone Quarrying and Processing	PM	Venturi Scrubber	OC, EC, PM25
Mineral Products - Stone Quarrying and Processing	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Mineral Products Industry	SO2	FGD	
Miscellaneous Metal Products Coatings	VOC	MACT	
Motor Vehicle Coating	VOC	Incineration	
Motor Vehicle Coating	VOC	MACT	
Municipal Solid Waste Landfill	VOC	Gas Collection (SCAQMD/BAAQMD)	
Municipal Waste Combustors	NOX	SNCR	NH3
Municipal Waste Incineration	PM	Dry ESP-Wire Plate Type	EC, PM25
Natural Gas Production; Compressors - Small Sources	NOX	SCR	NH3
Nitric Acid Manufacturing - Small Sources	NOX	Extended Absorption	
Nitric Acid Manufacturing - Small Sources	NOX	NSCR	NH3
Nitric Acid Manufacturing - Small Sources	NOX	SCR	NH3
Non-Ferrous Metals Processing - Aluminum	PM	CEM Upgrade and Increased Monitoring Frequency of	
Non-Ferrous Metals Processing - Aluminum	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Non-Ferrous Metals Processing - Aluminum	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Aluminum	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Aluminum	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Non-Ferrous Metals Processing - Aluminum	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Non-Ferrous Metals Processing - Copper	PM	CEM Upgrade and Increased Monitoring Frequency of	
Non-Ferrous Metals Processing - Copper	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Non-Ferrous Metals Processing - Copper	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Copper	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Copper	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Non-Ferrous Metals Processing - Copper	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Non-Ferrous Metals Processing - Lead	PM	CEM Upgrade and Increased Monitoring Frequency of	
Non-Ferrous Metals Processing - Lead	PM	Dry ESP-Wire Plate Type	OC, EC, PM25

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Non-Ferrous Metals Processing - Lead	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Lead	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Lead	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Non-Ferrous Metals Processing - Lead	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Non-Ferrous Metals Processing - Other	PM	CEM Upgrade and Increased Monitoring Frequency of	
Non-Ferrous Metals Processing - Other	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Non-Ferrous Metals Processing - Other	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Other	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Other	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Non-Ferrous Metals Processing - Other	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Non-Ferrous Metals Processing - Zinc	PM	CEM Upgrade and Increased Monitoring Frequency of	
Non-Ferrous Metals Processing - Zinc	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Non-Ferrous Metals Processing - Zinc	PM	Fabric Filter (Mech. Shaker Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Zinc	PM	Fabric Filter (Reverse-Air Cleaned Type)	OC, EC, PM25
Non-Ferrous Metals Processing - Zinc	PM	Increased Monitoring Frequency (IMF) of PM Control	OC, EC
Non-Ferrous Metals Processing - Zinc	PM	Wet ESP - Wire Plate Type	OC, EC, PM25
Nonroad Diesel Engines	PM	Heavy Duty Retrofit Program	OC, EC, PM25
Nonroad Gasoline Engines	VOC	Federal Reformulated Gasoline	
Off-Highway Diesel Vehicles	NOX	C-I Engine Standards	CO, VOC, PM25, PM10
Off-Highway Gasoline Vehicles	NOX	Large S-I Engine Standards	CO, VOC, PM25, PM10
Off-Highway Vehicles: All Terrain Vehicles (ATVs)	VOC	Recreational Gasoline ATV Standards	CO, NOX, PM25, PM10
Off-Highway Vehicles: Motorcycles	VOC	Off-Highway Motorcycle Standards	CO, NOX, PM25, PM10
Off-Highway Vehicles: Snowmobiles	VOC	Recreational Gasoline Snowmobile Standards	CO, NOX, PM25, PM10
Oil and Natural Gas Production - Fugitive Emissions	VOC	SCAQMD Proposed Rule 1148.1	
Oil and Natural Gas Production	VOC	Equipment and Maintenance	
Open Burning	NOX	Episodic Ban (Daily Only)	
Open Top Degreasing	VOC	Airtight Degreasing System	
Open Top Degreasing	VOC	MACT	
Open Top Degreasing	VOC	SCAQMD 1122 (VOC content limit)	
Paper Surface Coating	VOC	Incineration	
Paper and other Web Coating Operations	VOC	Permanent Total Enclosure (PTE)	
Paved Roads	PM	Vacuum Sweeping	OC, EC, PM25
Pesticide Application	VOC	Reformulation - FIP Rule	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Petroleum Industry	SO2	FGD	
Plastics Prod-Specific; (ABS) - Small Sources	NOX	LNB + FGR	
Portable Gasoline Containers	VOC	OTC Portable Gas Container Rule	
Poultry Operations	NH3	Chemical Additives to Waste	
Prescribed Burning	PM	Increase Fuel Moisture	OC, EC, PM25
Primary Lead Smelters - Sintering	SO2	Dual Absorption	
Primary Metals Industry	SO2	FGD	
Primary Zinc Smelters - Sintering	SO2	Dual Absorption	
Process Heaters (Oil and Gas Production)	SO2	FGD	
Process Heaters - Distillate Oil - Small Sources	NOX	LNB	NH3
Process Heaters - Distillate Oil - Small Sources	NOX	LNB + FGR	
Process Heaters - Distillate Oil - Small Sources	NOX	LNB + SCR	NH3
Process Heaters - Distillate Oil - Small Sources	NOX	LNB + SNCR	NH3
Process Heaters - Distillate Oil - Small Sources	NOX	SCR	NH3
Process Heaters - Distillate Oil - Small Sources	NOX	SNCR	NH3
Process Heaters - Distillate Oil - Small Sources	NOX	ULNB	
Process Heaters - LPG - Small Sources	NOX	LNB	NH3
Process Heaters - LPG - Small Sources	NOX	LNB + FGR	
Process Heaters - LPG - Small Sources	NOX	LNB + SCR	NH3
Process Heaters - LPG - Small Sources	NOX	LNB + SNCR	NH3
Process Heaters - LPG - Small Sources	NOX	SCR	NH3
Process Heaters - LPG - Small Sources	NOX	SNCR	NH3
Process Heaters - LPG - Small Sources	NOX	ULNB	
Process Heaters - Natural Gas - Small Sources	NOX	LNB	NH3
Process Heaters - Natural Gas - Small Sources	NOX	LNB + FGR	
Process Heaters - Natural Gas - Small Sources	NOX	LNB + SCR	NH3
Process Heaters - Natural Gas - Small Sources	NOX	LNB + SNCR	NH3
Process Heaters - Natural Gas - Small Sources	NOX	SCR	NH3
Process Heaters - Natural Gas - Small Sources	NOX	SNCR	NH3
Process Heaters - Natural Gas - Small Sources	NOX	ULNB	
Process Heaters - Other Fuel - Small Sources	NOX	LNB	NH3
Process Heaters - Other Fuel - Small Sources	NOX	LNB + FGR	
Process Heaters - Other Fuel - Small Sources	NOX	LNB + SCR	NH3

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Process Heaters - Other Fuel - Small Sources	NOX	LNB + SNCR	NH3
Process Heaters - Other Fuel - Small Sources	NOX	SCR	NH3
Process Heaters - Other Fuel - Small Sources	NOX	SNCR	NH3
Process Heaters - Other Fuel - Small Sources	NOX	ULNB	
Process Heaters - Process Gas - Small Sources	NOX	LNB	NH3
Process Heaters - Process Gas - Small Sources	NOX	LNB + FGR	
Process Heaters - Process Gas - Small Sources	NOX	LNB + SCR	NH3
Process Heaters - Process Gas - Small Sources	NOX	LNB + SNCR	NH3
Process Heaters - Process Gas - Small Sources	NOX	SCR	NH3
Process Heaters - Process Gas - Small Sources	NOX	SNCR	NH3
Process Heaters - Process Gas - Small Sources	NOX	ULNB	
Process Heaters - Residual Oil - Small Sources	NOX	LNB	NH3
Process Heaters - Residual Oil - Small Sources	NOX	LNB + FGR	
Process Heaters - Residual Oil - Small Sources	NOX	LNB + SCR	NH3
Process Heaters - Residual Oil - Small Sources	NOX	LNB + SNCR	NH3
Process Heaters - Residual Oil - Small Sources	NOX	SCR	NH3
Process Heaters - Residual Oil - Small Sources	NOX	SNCR	NH3
Process Heaters - Residual Oil - Small Sources	NOX	ULNB	
Product and Packaging Rotogravure and Screen Printing	VOC	Permanent Total Enclosure (PTE)	
Publication Rotogravure Printing	VOC	Permanent Total Enclosure (PTE)	
Pulp and Paper Industry (Sulfate Pulping)	SO2	FGD	
Residential Home Heating	PM	Switch to Low Sutfur Fuel	SO2, NOX
Residential Natural Gas	NOX	Water Heater + LNB Space Heaters	
Residential Natural Gas	NOX	Water Heater Replacement	
Residential Wood Combustion	PM	Education and Advisory Program	OC, EC, PM25
Residential Wood Stoves	PM	NSPS compliant Wood Stoves	
Residual Oil (Commercial/Institutional Boilers)	SO2	FGD	
Residual Oil (Commercial/Institutional Boilers)	SO2	Wet FGD	
Residual Oil (Industrial Boilers	SO2	FGD	
Rich-Burn Stationary Reciprocating Internal Combustion Engines (RICE)	NOX	NSCR	CO, VOC
Rich-Burn Stationary Reciprocating Internal Combustion Engines	NOX	NSCR	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Rubber and Plastics Manufacturing	VOC	SCAQMD - Low VOC	
Sand/Gravel; Dryer - Small Sources	NOX	LNB + FGR	
Secondary Aluminum Production; Smelting Furnaces	NOX	LNB	
Secondary Metal Production	SO2	FGD	
Solid Waste Disposal; Government; Other	NOX	SNCR	NH3
Space Heaters - Distillate Oil - Small Sources	NOX	LNB	
Space Heaters - Distillate Oil - Small Sources	NOX	LNB + FGR	
Space Heaters - Distillate Oil - Small Sources	NOX	SCR	NH3
Space Heaters - Distillate Oil - Small Sources	NOX	SNCR	NH3
Space Heaters - Natural Gas - Small Sources	NOX	LNB	
Space Heaters - Natural Gas - Small Sources	NOX	LNB + FGR	
Space Heaters - Natural Gas - Small Sources	NOX	OT + WI	
Space Heaters - Natural Gas - Small Sources	NOX	SCR	NH3
Space Heaters - Natural Gas - Small Sources	NOX	SNCR	NH3
Stage II Service Stations - Underground Tanks	VOC	Low Pressure/Vacuum Relief Valve	
Stage II Service Stations	VOC	Low Pressure/Vacuum Relief Valve	
Starch Manufacturing; Combined Operation - Small Sources	NOX	LNB + FGR	
Steam Generating Unit-Coal/Oil	SO2	FGD	
Steel Foundries; Heat Treating	NOX	LNB	
Steel Production; Soaking Pits	NOX	LNB + FGR	
Sulfate Pulping - Recovery Furnaces - Small Sources	NOX	LNB	
Sulfate Pulping - Recovery Furnaces - Small Sources	NOX	LNB + FGR	
Sulfate Pulping - Recovery Furnaces - Small Sources	NOX	OT + WI	
Sulfate Pulping - Recovery Furnaces - Small Sources	NOX	SCR	NH3
Sulfate Pulping - Recovery Furnaces - Small Sources	NOX	SNCR	NH3
Sulfur Recovery Plants - Elemental Sulfur	SO2	Amine Scrubbing	
Sulfur Recovery Plants - Elemental Sulfur	SO2	Amine Scrubbing + FGD	
Sulfuric Acid Plants - Contact Absorbers	SO2	FGD	
Sulfuric Acid Plants - Contact Absorbers	SO2	Incr. Absorption Eff. to NSPS Level (99.7%)	
Sulfuric Acid Plants - Contact Absorbers	SO2	Incr. Absorption Eff. to NSPS Level (99.7%) + FGD	
Surface Coat Oper; Coating Oven Htr; Nat Gas - Small Sources	NOX	LNB	NH3
Traffic Markings	VOC	AIM Coating Federal Rule	

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Traffic Markings	VOC	South Coast Phase I	
Traffic Markings	VOC	South Coast Phase II	
Traffic Markings	VOC	South Coast Phase III	
Unpaved Roads	PM	Chemical Stabilization	EC, PM25
Unpaved Roads	PM	Hot Asphalt Paving	OC, EC, PM25
Utility Boiler - Coal/Tangential	NOX	NGR	
Utility Boiler - Coal/Tangential	NOX	SCR	Hg, NH3
Utility Boiler - Coal/Tangential	NOX	SNCR	NH3
Utility Boiler - Coal/Tangential	NOX	LNC1	
Utility Boiler - Coal/Tangential	NOX	LNC2	
Utility Boiler - Coal/Tangential	NOX	LNC3	
Utility Boiler - Coal/Wall	NOX	NGR	
Utility Boiler - Coal/Wall	NOX	SCR	NH3
Utility Boiler - Coal/Wall	NOX	SNCR	NH3
Utility Boiler - Coal/Wall	NOX	LNB	
Utility Boiler - Coal/Wall	NOX	LNBO	
Utility Boiler - Cyclone	NOX	NGR	
Utility Boiler - Cyclone	NOX	SCR	NH3
Utility Boiler - Cyclone	NOX	SNCR	NH3
Utility Boiler - Oil-Gas/Tangential	NOX	NGR	
Utility Boiler - Oil-Gas/Tangential	NOX	SCR	NH3
Utility Boiler - Oil-Gas/Tangential	NOX	SNCR	NH3
Utility Boiler - Oil-Gas/Wall	NOX	NGR	
Utility Boiler - Oil-Gas/Wall	NOX	SCR	NH3
Utility Boiler - Oil-Gas/Wall	NOX	SNCR	NH3
Utility Boilers - Coal-Fired	SO2	Coal Washing	Hg, PM25, PM10
Utility Boilers - Coal-Fired	SO2	Fuel Switching	PM25, PM10
Utility Boilers - Coal-Fired	SO2	Repowering	Hg, NOX
Utility Boilers - Coal	PM	Dry ESP-Wire Plate Type	Hg, OC, EC, PM25
Utility Boilers - Coal	PM	Fabric Filter	Hg, OC, EC, PM25
Utility Boilers - Coal	PM	Fabric Filter (Mech. Shaker Type)	Hg, OC, EC, PM25
Utility Boilers - Coal	PM	Fabric Filter (Pulse Jet Type)	Hg, OC, EC, PM25
Utility Boilers - Coal	PM	Fabric Filter (Reverse-Air Cleaned Type)	Hg, OC, EC, PM25

Table III-1 (continued)

Source Category	Major Pollutant	Control Measure	Other Pollutant
Utility Boilers - Gas/Oil	PM	Fabric Filter	Hg, OC, EC, PM25
Utility Boilers - High Sulfur Content	SO2	FGD Wet Scrubber	Hg
Utility Boilers - Medium Sulfur Content	SO2	FGD Wet Scrubber	Hg
Utility Boilers - Very High Sulfur Content	SO2	FGD Wet Scrubber	Hg
Wood Furniture Surface Coating	VOC	Add-On Controls	
Wood Furniture Surface Coating	VOC	MACT	
Wood Furniture Surface Coating	VOC	New CTG	
Wood Product Surface Coating	VOC	Incineration	
Wood Product Surface Coating	VOC	MACT	
Wood Product Surface Coating	VOC	SCAQMD Rule 1104	
Wood Pulp & Paper	PM	Dry ESP-Wire Plate Type	OC, EC, PM25
Wood Pulp & Paper	PM	Wet ESP - Wire Plate Type	OC, EC, PM25

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CHAPTER IV
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APPENDIX A: DATA STRUCTURE TABLES

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Table A-1. Data Structure of meas_all_<year>.dbf

Field Name	Description	Type	Width	Decimals
MEASREC	Unique Measure Number	C	7	
SECTOR	Sector	C	5	
POLLUTANT	Pollutant	C	1	
MEAS	Measure Code	C	6	
FIPSST	FIPS State	C	2	
FIPSCNTY	FIPS County	C	3	
PLANTID	Plant ID	C	15	
POINTID	Point ID	C	15	
STACKID	Stack ID	C	12	
ORISID	ORIS ID	C	6	
BLRID	Boiler ID	C	6	
SEGMENT	Segment	C	2	
SCC	Source Classification Code	C	10	
PLANT	Plant Name	C	40	
SIC	Standard Industrial Classification	C	4	
INCVOC	VOC Reduced by Measure (tpy)	N	8	3
INCNOX	NO_x Reduced by Measure (tpy)	N	8	3
INCSO2	SO_2 Reduced by Measure (tpy)	N	8	3
INCPM10	PM_{10} Reduced by Measure (tpy)	N	8	3
INCPM25	$PM_{2.5}$ Reduced by Measure (tpy)	N	8	3
INCNH3	NH_3 Reduced by Measure (tpy)	N	8	3
INCCO	CO Reduced by Measure (tpy)	N	8	3
INCOC	OC Reduced by Measure (tpy)	N	8	3
INCEC	EC Reduced by Measure (tpy)	N	8	3
INCHG	HG Reduced by Measure (tpy)	N	8	3
TCOST	Total Cost (1997$)	N	12	
CPTON	Cost per Ton Reduced (1997$)	N	10	
CAPCOST	Capital Cost (1997$)	N	12	
OMCOST	O&M Cost (1997$)	N	12	
VOC_CE	Current VOC Control Efficiency	N	7	2
VOC_RE	Current VOC Rule Effectiveness	N	3	
VOC_RP	Current VOC Rule Penetration	N	3	
VOC_ANN	Current VOC Annual Emissions (tpy)	N	13	4
V_MEAS_CE	Measure VOC Control Efficiency	N	7	2
V_MEAS_RE	Measure VOC Rule Effectiveness	N	3	
V_MEAS_RP	Measure VOC Rule Penetration	N	3	
NOX_CE	Current NO_x Control Efficiency	N	7	2
NOX_RE	Current NO_x Rule Effectiveness	N	3	
NOX_RP	Current NO_x Rule Penetration	N	3	
NOX_ANN	Current NO_x Annual Emissions (tpy)	N	13	4
N_MEAS_CE	Measure NO_x Control Efficiency	N	7	2
N_MEAS_RE	Measure NO_x Rule Effectiveness	N	3	

Table A-1 (continued)

Field Name	Description	Type	Width	Decimals
N_MEAS_RP	Measure NO_x Rule Penetration	N	3	
PM10_CE	Current PM_{10} Control Efficiency	N	7	2
PM25_CE	Current $PM_{2.5}$ Control Efficiency	N	7	2
PM10_RE	Current PM_{10} Rule Effectiveness	N	3	
PM25_RE	Current $PM_{2.5}$ Rule Effectiveness	N	3	
PM10_RP	Current PM_{10} Rule Penetration	N	3	
PM25_RP	Current $PM_{2.5}$ Rule Penetration	N	3	
PM10_ANN	Current PM_{10} Annual Emissions (tpy)	N	13	4
PM25_ANN	Current $PM_{2.5}$ Annual Emissions (tpy)	N	13	4
P1_MEAS_CE	Measure PM_{10} Control Efficiency	N	7	2
P2_MEAS_CE	Measure $PM_{2.5}$ Control Efficiency	N	7	2
P1_MEAS_RE	Measure PM_{10} Rule Effectiveness	N	3	
P2_MEAS_RE	Measure $PM_{2.5}$ Rule Effectiveness	N	3	
P1_MEAS_RP	Measure PM_{10} Rule Penetration	N	3	
P2_MEAS_RP	Measure $PM_{2.5}$ Rule Penetration	N	3	
SO2_CE	Current SO_2 Control Efficiency	N	7	2
SO2_RE	Current SO_2 Rule Effectiveness	N	3	
SO2_RP	Current SO_2 Rule Penetration	N	3	
SO2_ANN	Current SO_2 Annual Emissions (tpy)	N	13	4
S_MEAS_CE	Measure SO_2 Control Efficiency	N	7	2
S_MEAS_RE	Measure SO_2 Rule Effectiveness	N	3	
S_MEAS_RP	Measure SO_2 Rule Penetration	N	3	
NH3_CE	Current NH_3 Control Efficiency	N	7	2
NH3_RE	Current NH_3 Rule Effectiveness	N	3	
NH3_RP	Current NH_3 Rule Penetration	N	3	
NH3_ANN	Current NH_3 Annual Emissions (tpy)	N	13	4
A_MEAS_CE	Measure NH_3 Control Efficiency	N	7	2
A_MEAS_RE	Measure NH_3 Rule Effectiveness	N	3	
A_MEAS_RP	Measure NH_3 Rule Penetration	N	3	
CO_CE	Current CO Control Efficiency	N	7	2
CO_RE	Current CO Rule Effectiveness	N	3	
CO_RP	Current CO Rule Penetration	N	3	
CO_ANN	Current CO Annual Emissions (tpy)	N	13	4
C_MEAS_CE	Measure CO Control Efficiency	N	7	2
C_MEAS_RE	Measure CO Rule Effectiveness	N	3	
C_MEAS_RP	Measure CO Rule Penetration	N	3	
OC_CE	Current OC Control Efficiency	N	7	2
OC_RE	Current OC Rule Effectiveness	N	3	
OC_RP	Current OC Rule Penetration	N	3	
O_MEAS_CE	Measure OC Control Efficiency	N	7	2
O_MEAS_RE	Measure OC Rule Effectiveness	N	3	
O_MEAS_RP	Measure OC Rule Penetration	N	3	

Table A-1 (continued)

Field Name	Description	Type	Width	Decimals
EC_CE	Current EC Control Efficiency	N	7	2
EC_RE	Current EC Rule Effectiveness	N	3	
EC_RP	Current EC Rule Penetration	N	3	
E_MEAS_CE	Measure EC Control Efficiency	N	7	2
E_MEAS_RE	Measure EC Rule Effectiveness	N	3	
E_MEAS_RP	Measure EC Rule Penetration	N	3	
HG_CE	Current Hg Control Efficiency	N	7	2
HG_RE	Current Hg Rule Effectiveness	N	3	
HG_RP	Current Hg Rule Penetration	N	3	
H_MEAS_CE	Measure Hg Control Efficiency	N	7	2
H_MEAS_RE	Measure Hg Rule Effectiveness	N	3	
H_MEAS_RP	Measure Hg Rule Penetration	N	3	
COSTYEAR	Dollar Year that Costs are expressed in	C	4	
EXPER	Experimental Flag (Y= Yes, blank = No)	C	1	

Table A-2. Data Structure of tacn_keys_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
KEYID	Used to join with all tables	N	6	0
MEASID	Unique Measure Number	N	3	0
GEOID	Select Field	N	4	0
SCCSECTID	Pollutant	N	5	0
PLANTID	Control	N	5	0
POINTID	Source	N	4	0
SICNAICSID	Emission Reduction NO_x	N	5	0
STACKID	Emission Reduction VOC	N	3	0
SEGMENTID	Emission Reduction SO_2	N	3	0

Table A-3. Data Structure of tacn_emissions_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
KEYID	Used to join with Key table	N	6	0
TOTALCOST	Unique Measure Number	N	10	0
OMCOST	Select Field	N	10	0
CAPCOST	Pollutant	N	10	0
COSTPERTON	Control	N	10	0
INCRE_COST	Source	N	10	0
INCNOX	Emission Reduction NO_x	N	7	3
INCVOC	Emission Reduction VOC	N	7	3
INCSO2	Emission Reduction SO_2	N	7	3
INCPM10	Emission Reduction PM_{10}	N	7	3
INCPM25	Emission Reduction $PM_{2.5}$	N	7	3
INCNH3	Emission Reduction NH_3	N	7	3
INCOC	Emission Reduction OC	N	7	3
INCEC	Emission Reduction EC	N	7	3
INCCO	Emission Reduction CO	N	8	2
INCHG	Emission Reduction Hg	N	7	5
NOX_ANN	Current NO_x Annual Emissions (tpy)	N	7	3
VOC_ANN	Current VOC Annual Emissions (tpy)	N	7	3
SO2_ANN	Current SO_2 Annual Emissions (tpy)	N	7	3
PM10_ANN	Current PM_{10} Annual Emissions (tpy)	N	7	3
PM25_ANN	Current $PM_{2.5}$ Annual Emissions (tpy)	N	7	3
NH3_ANN	Current NH_3 Annual Emissions (tpy)	N	7	3
OC_ANN	Current OC Annual Emissions (tpy)	N	7	3
EC_ANN	Current EC Annual Emissions (tpy)	N	7	3
CO_ANN	Current CO Annual Emissions (tpy)	N	8	2
HG_ANN	Current Hg Annual Emissions (tpy)	N	7	5
INCRE_NOX	Incremental Control Reductions: NO_x	N	7	3
INCRE_VOC	Incremental Control Reductions: VOC	N	7	3
INCRE_SO2	Incremental Control Reductions: SO_2	N	7	3
INCRE_PM10	Incremental Control Reductions: PM_{10}	N	7	3
INCRE_PM25	Incremental Control Reductions: $PM_{2.5}$	N	7	3
INCRE_NH3	Incremental Control Reductions: NH_3	N	7	3
INCRE_OC	Incremental Control Reductions: OC	N	7	3
INCRE_EC	Incremental Control Reductions: EC	N	7	3
INCRE_CO	Incremental Control Reductions CO	N	8	2
INCRE_HG	Incremental Control Reductions: Hg	N	7	5

Table A-4. Data Structure of tacn_keys_maxtpollutant_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
KEYID	Used to join with all tables	N	6	
MAXTPOLL	Pollutant name used in conjunction with keyid to indicate which pollutant for keyid's row is the maximum reduction	C	4	

Table A-5. Data Structure of tlacn_segment_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
SEGMENTID	Segment ID	N	3	
SEGMENT	Segment	C	4	

Table A-6. Data Structure of tacn_keys_ignorepollutant_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
KEYID	Used to join with all tables	N	6	
DELETEPOLL	Pollutant name used in conjunction with keyid to indicate which pollutant for keyid's row should be ignored	C	4	

Table A-7. Data Structure of tlacn_sccsector_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
SCCSECTID	SCC Sector ID	N	5	
SCC	Source Classification Code	C	10	
SECTOR	Sector	C	5	
SCC12	SCC Tiers 1-2	C	2	
SCC34	SCC Tiers 3-4	C	2	
SCC67	SCC Tiers 6-7	C	3	
SCC810	SCC Tiers 8-10	C	3	
DESC12	Description of SCC Tiers 1-2	C	54	
DESC34	Description of SCC Tiers 3-4	C	54	
DESC67	Description of SCC Tiers 6-7	C	70	
DESC810	Description of SCC Tiers 8-10	C	70	

Table A-8. Data Structure of tacn_remsadtotals_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
REMSADSECT	Regulatory Modeling System for Aerosols and Deposition Sector	C	1	
REMSADKEY	Regulatory Modeling System for Aerosols and Deposition Key	C	23	
NOX_TOT	Total NOx emissions for NEI	N	13	4
VOC_TOT	Total VOC emissions for NEI	N	13	4
PM10_TOT	Total PM_{10} emissions for NEI	N	13	4
PM25_TOT	Total $PM_{2.5}$ emissions for NEI	N	13	4
SO2_TOT	Total SO_2 emissions for NEI	N	13	4
NH3_TOT	Total NH_3 emissions for NEI	N	13	4
SOA_TOT	Total	N	13	4
CO_TOT	Total CO emissions for NEI	N	13	4
HG_TOT	Total Hg emissions for NEI	N	13	4

Table A-9. Data Structure of tlacn_geographic_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
GEOID	Unique geographic identifier	N	4	
FIPSST	FIPS State	C	2	
FIPSCNTY	FIPS County	C	3	
STATENM	State Name	C	15	
STATEABR	State Abbreviation	C	2	
COUNTYNM	County Name	C	25	
CBSA	Census Bureau Statistical Area	C	5	
CBSATYPE	CBSA type	C	6	
CBSANAME	CBSA name	C	80	

Table A-10. Data Structure of tlacn_point_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
POINTID	Unique Point Identifier (determined by us)	N	4	
POINTID2	Text Point Identifier (determined by EPA, the States, someone else?)	C	15	

Table A-11. Data Structure of tacn_effectiveness_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
KEYID	Used to join with all tables	N	6	
NOX_CE	Current NO_x Control Efficiency	N	7	2
VOC_CE	Current VOC Control Efficiency	N	7	2
SO2_CE	Current SO_2 Control Efficiency	N	7	2
NH3_CE	Current NH_3 Control Efficiency	N	7	2
PM10_CE	Current PM_{10} Control Efficiency	N	7	2
PM25_CE	Current $PM_{2.5}$ Control Efficiency	N	7	2
OC_CE	Current OC Control Efficiency	N	7	2
EC_CE	Current EC Control Efficiency	N	7	2
CO_CE	Current CO Control Efficiency	N	7	2
HG_CE	Current Hg Control Efficiency	N	7	2
NOX_RE	Current NO_x Rule Effectiveness	N	3	
VOC_RE	Current VOC Rule Effectiveness	N	3	
SO2_RE	Current SO_2 Rule Effectiveness	N	3	
NH3_RE	Current NH_3 Rule Effectiveness	N	3	
PM10_RE	Current PM_{10} Rule Effectiveness	N	3	
PM25_RE	Current $PM_{2.5}$ Rule Effectiveness	N	3	
OC_RE	Current OC Rule Effectiveness	N	3	
EC_RE	Current EC Rule Effectiveness	N	3	
CO_RE	Current CO Rule Effectiveness	N	3	
HG_RE	Current Hg Rule Effectiveness	N	3	

Table A-12. Data Structure of tlacn_plant_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
PLANTID	Unique Plant Identifier (determined by us)	N	5	
PLANTID2	Text Plant Identifier (determined by EPA, the States, someone else?)	C	15	
PLANTNAME	Plant Name	C	40	

Table A-13. Data Structure of tlacn_sic4naics3_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
SICNAICSID	Unique SIC/NAICS Identifier	N	3	
SIC4	Standard Industrial Classification Code	C	4	
NAICS3	North American Industry Classification System Code	C	3	
N3LABEL	NAICS3 description	C	123	

Table A-14. Data Structure of tlacn_meas_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
MEASID	Unique Measure Identifier	N	3	
MEAS	Measure Code	C	6	
MEASNAME	Measure Name	C	50	
LMEASNAME	Long Measure Name / Description	C	95	
SOURCE	Source	C	88	
CPOLLUTANT	Criteria Pollutant	C	3	
SECTOR	Sector	C	6	
COST_YEAR	Cost Year	C	4	
EDITABLE	Indicates whether the current measure is editable	L	1	
I	Interest Rate	N	8	4
CE	Control Efficiency	N	6	3
ELEC_RT	Electricity Rate ($ per kWh)	N	8	4
NG_RT	Natural Gas Rate ($ per cf)	N	6	3
OPLBR_RT	Operating Labor Rate ($ per hour)	N	6	3
MNTLBR_RT	Maintenance Labor Rate ($ per hour)	N	6	3
EQP_LIFE	Equipment Life (years)	N	3	
OPLBR_PCT	Operating Labor (% of OM COST)	N	8	4
MNTLBR_PCT	Maintenance Labor (% of OM COST)	N	8	4
SPVLBR_PCT	Supervisory Labor (% of OM COST)	N	8	4
MNTMTL_PCT	Maintenance Materials (% of OM COST)	N	8	4
RPLMTL_PCT	Replacement Materials (% of OM COST)	N	8	4
ELEC_PCT	Electricity (% of OM COST)	N	8	4
STEAM_PCT	Steam (% of OM COST)	N	8	4
FUEL_PCT	Fuel (% of OM COST)	N	8	4
WSTDSP_PCT	Waste Disposal (% of OM COST)	N	8	4
CHEM_PCT	Chemicals (% of OM COST)	N	8	4
OMATL_PCT	Other Materials (% of OM COST)	N	8	4
OTHR_PCT	Other (% of OM COST)	N	8	4
UTIL_PCT	Other Utility Percentage of O&M Costs (% of OM COST)	N	8	4
TDIR_PCT	Total Direct Costs (% of OM COST)	N	8	4
OVRHD_PCT	Overhead (% of OM COST)	N	8	4
ADMIN_PCT	Administrative (% of OM COST)	N	8	4
PROPTX_PCT	Property Tax (% of OM COST)	N	8	4
INSRNC_PCT	Insurance (% of OM COST)	N	8	4
TINDIR_PCT	Total Indirect Costs (% of OM COST)	N	8	4

Table A-15. Data Structure of tlacn_sic2_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
SIC2	Standard Industrial Classification Code	C	2	
BOXLABEL	SIC2 Description	C	45	

Table A-16. Data Structure of TLACN_STACK_<data set name>.dbf

Field Name	Description	Type	Width	Decimals
STACKID	Stack ID	N	4	
STACK	Stack Name	C	12	

APPENDIX B: CONTROL MEASURE SUMMARY LIST BY POLLUTANT

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Appendix B Control Measure Summary List by Source Category (1999 Baseline) - Sorted alphabetically by Pollutant and Source Category

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Cattle Feedlots	Chemical Additives to Waste								√*				50%			228	
Hog Operations	Chemical Additives to Waste								√*				50%			73	
Poultry Operations	Chemical Additives to Waste								√*				75%			1,014	
Agricultural Burning	Seasonal Ban (Ozone Season Daily)					√*							100%			N/A	
Ammonia - Natural Gas - Fired Reformers - Small Sources	Oxygen Trim + Water Injection					√*							65%			680	
Ammonia - Natural Gas - Fired Reformers - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		2,900	3,870	3,870
Ammonia - Natural Gas - Fired Reformers - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		2,230	2,230	2,860
Ammonia - Natural Gas - Fired Reformers - Small Sources	Low NOx Burner					√*							50%			820	
Ammonia - Natural Gas - Fired Reformers - Small Sources	Low NOx Burner (LNB) + Flue Gas Recirculation (FGR)					√*							60%		2,470	2,560	2,560
Ammonia Products; Feedstock Desulfurization - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		2,470	2,560	2,560
Asphaltic Conc; Rotary Dryer; Conv Plant - Small Sources	Low NOx Burner					√*							50%			2,200	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
By-Product Coke Manufacturing; Oven Underfiring	Selective Non-Catalytic Reduction (SNCR)					√*			X				60%			1,640	
Cement Kilns	Biosolid Injection					√*							23%			310	
Cement Manufacturing - Dry	Mid-Kiln Firing					√*							25%		-460	55	730
Cement Manufacturing - Dry	Selective Non-Catalytic Reduction (SNCR) Urea Based					√*			X				50%			770	
Cement Manufacturing - Dry	Selective Catalytic Reduction (SCR)					√*			X				80%			3,370	
Cement Manufacturing - Dry	Selective Non-Catalytic Reduction (SNCR) Ammonia Based					√*			X				50%			850	
Cement Manufacturing - Dry	Low NOx Burner					√*							25%		300	440	620
Cement Manufacturing - Wet	Mid-Kiln Firing					√*							25%		-460	55	730
Cement Manufacturing - Wet	Low NOx Burner					√*							25%		300	440	620
Cement Manufacturing - Wet - Large Sources	Selective Catalytic Reduction (SCR)					√*			X				80%			2,880	
Cement Manufacturing - Wet - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%			2,880	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Ceramic Clay Manufacturing; Drying - Small Sources	Low NOx Burner					√*							50%			2,200	
Coal Cleaning-Thrml Dryer; Fluidized Bed - Small Sources	Low NOx Burner					√*							50%			1,460	
Coal-fired Plants with Production Capacities>100MW	Combustion Optimization					√*							20%			-25	
Combustion Turbines - Jet Fuel - Small Sources	Selective Catalytic Reduction (SCR) + Water Injection					√*							90%			2,300	
Combustion Turbines - Jet Fuel - Small Sources	Water Injection					√*							68%			1,290	
Combustion Turbines - Natural Gas - Large Sources	Dry Low NOx Combustors					√*							50%		100	100	140
Combustion Turbines - Natural Gas - Small Sources	Selective Catalytic Reduction (SCR) + Water Injection					√*							95%			2,730	
Combustion Turbines - Natural Gas - Small Sources	Selective Catalytic Reduction (SCR) + Steam Injection					√*			X				95%		2,010	2,010	8,960
Combustion Turbines - Natural Gas - Small Sources	Steam Injection					√*							80%			1,040	
Combustion Turbines - Natural Gas - Small Sources	Water Injection					√*							76%			1,510	
Combustion Turbines - Natural Gas - Small Sources	Selective Catalytic Reduction (SCR) + Low NOx Burner (LNB)					√*			X				94%		2,570	2,570	19,120

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Combustion Turbines - Natural Gas - Small Sources	Dry Low NOx Combustors					√*							84%		490	490	540
Combustion Turbines - Oil - Small Sources	Selective Catalytic Reduction (SCR) + Water Injection					√*							90%			2,300	
Combustion Turbines - Oil - Small Sources	Water Injection					√*							68%			1,290	
Commercial/Institutional - Natural Gas	Water Heater Replacement					√*							7%			N/A	
Commercial/Institutional - Natural Gas	Water Heaters + LNB Space Heaters					√*							7%			1,230	
Commercial/Institutional Incinerators	Selective Non-Catalytic Reduction (SNCR)					√*			X				45%			1,130	
Conv Coating of Prod; Acid Cleaning Bath - Small Sources	Low NOx Burner					√*							50%			2,200	
Diesel Locomotives	Selective Catalytic Reduction (SCR)					√*							72%			1,400	
Fiberglass Manufacture; Textile-Type; Recuperative Furnaces	Low NOx Burner					√*							40%			1,690	
Fluid Catalytic Cracking Units - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							55%		1,430	3,190	3,190
Fuel Fired Equipment - Process Heaters	Low NOx Burner + Flue Gas Recirculation					√*							50%			570	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Fuel Fired Equipment; Furnaces; Natural Gas	Low NOx Burner					√*							50%			570	
Glass Manufacturing - Containers	OXY-Firing					√*							85%			4,590	
Glass Manufacturing - Containers	Electric Boost					√*							10%			7,150	
Glass Manufacturing - Containers	Cullet Preheat					√*							25%			940	
Glass Manufacturing - Containers	Low NOx Burner					√*							40%			1,690	
Glass Manufacturing - Containers	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%			1,770	
Glass Manufacturing - Containers	Selective Catalytic Reduction (SCR)					√*			X				75%			2,200	
Glass Manufacturing - Flat	OXY-Firing					√*							85%			1,900	
Glass Manufacturing - Flat	Low NOx Burner					√*							40%			700	
Glass Manufacturing - Flat	Electric Boost					√*							10%			2,320	
Glass Manufacturing - Flat - Large Sources	Selective Catalytic Reduction (SCR)					√*			X				75%			710	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Glass Manufacturing - Flat - Large Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%			740	
Glass Manufacturing - Flat - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				75%			710	
Glass Manufacturing - Flat - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%			740	
Glass Manufacturing - Pressed	Cullet Preheat					√*							25%			810	
Glass Manufacturing - Pressed	Low NOx Burner					√*							40%			1,500	
Glass Manufacturing - Pressed	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%			1,640	
Glass Manufacturing - Pressed	Selective Catalytic Reduction (SCR)					√*			X				75%			2,530	
Glass Manufacturing - Pressed	OXY-Firing					√*							85%			3,900	
Glass Manufacturing - Pressed	Electric Boost					√*							10%			8,760	
Highway Vehicles - Gasoline Engine	Low Reid Vapor Pressure (RVP) Limit in Ozone Season					√	√*			√		0.1%	5.5%	11.1%	125	1,548	25,671
Highway Vehicles - Heavy Duty and Diesel-Fueled Vehicles	Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Controls	√	√			√*	√	√		√			76%			10,561	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Highway Vehicles - Heavy Duty and Diesel-Fueled Vehicles	Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Controls	√	√			√*	√	√		√			44%			10,561	
Highway Vehicles - Heavy Duty and Diesel-Fueled Vehicles	Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Controls	√	√			√*	√	√		√			61%			10,561	
Highway Vehicles - Heavy Duty and Diesel-Fueled Vehicles	Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Controls	√	√			√*	√	√		√			19%			9,301	
Highway Vehicles - Heavy Duty Diesel Engines	Voluntary Diesel Retrofit Program: Selective Catalytic Reduction	√	√			√*	√	√		√			19.26%			50,442	
Highway Vehicles - Light Duty and Gasoline-Fueled Vehicles	Tier 2 Motor Vehicle Emissions and Gasoline Sulfur Controls	√	√			√*	√	√		√		74%	83%	92%		6,297	
Highway Vehicles - Light Duty and Gasoline-Fueled Vehicles	Tier 2 Motor Vehicle Emissions and Gasoline Sulfur Controls	√	√			√*	√	√		√		43%	54.5%	66%		6,297	
Highway Vehicles - Light Duty and Gasoline-Fueled Vehicles	Tier 2 Motor Vehicle Emissions and Gasoline Sulfur Controls	√	√			√*	√	√		√		52%	64.5%	77%		6,297	
Highway Vehicles - Light Duty and Gasoline-Fueled Vehicles	Tier 2 Motor Vehicle Emissions and Gasoline Sulfur Controls	√	√			√*	√	√		√		28%	34%	40%		6,297	
Highway Vehicles - Light Duty Gasoline Engines	High Enhanced Inspection and Maintenance (I/M) Program					√*	√			√		0.4%	6.5%	13.4%	3,900	7,949	218,369
IC Engines - Gas	L-E (Low Speed)					√*							87%			176	
IC Engines - Gas - Small Sources	Selective Catalytic Reduction (SCR)					√*							90%			2,769	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
IC Engines - Gas, Diesel, LPG - Small Sources	Selective Catalytic Reduction (SCR)					√*							80%			2,340	
IC Engines - Gas, Diesel, LPG - Small Sources	Ignition Retard					√*							25%			770	
ICI Boilers - Coal/Cyclone - Large Sources	Coal Reburn					√*							50%			300	
ICI Boilers - Coal/Cyclone - Small Sources	Selective Catalytic Reduction (SCR)					√*							80%			820	
ICI Boilers - Coal/Cyclone - Small Sources	Natural Gas Reburn (NGR)					√*							55%			1,570	
ICI Boilers - Coal/Cyclone - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				35%			840	
ICI Boilers - Coal/Cyclone - Small Sources	Coal Reburn					√*							50%			1,570	
ICI Boilers - Coal/FBC - Large Sources	Selective Non-Catalytic Reduction (SNCR) Urea Based					√*			X				40%			670	
ICI Boilers - Coal/FBC - Small Sources	Selective Non-Catalytic Reduction (SNCR) Urea Based					√*			X				75%			900	
ICI Boilers - Coal/Stoker - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%		873	1,015	1,015
ICI Boilers - Coal/Stoker - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%			817	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
ICI Boilers - Coal/Wall - Large Sources	Low NOx Burner					√*							50%			1,090	
ICI Boilers - Coal/Wall - Large Sources	Selective Catalytic Reduction (SCR)					√*			X				70%			1,070	
ICI Boilers - Coal/Wall - Large Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%			840	
ICI Boilers - Coal/Wall - Small Sources	Selective Catalytic Reduction (SCR)					√*							70%			1,260	
ICI Boilers - Coal/Wall - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%		400	1,040	1,040
ICI Boilers - Coal/Wall - Small Sources	Low NOx Burner					√*							50%			1,460	
ICI Boilers - Coke - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%		400	1,040	1,040
ICI Boilers - Coke - Small Sources	Low NOx Burner					√*							50%			1,460	
ICI Boilers - Coke - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				70%			1,260	
ICI Boilers - Distillate Oil - Large Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%			1,890	
ICI Boilers - Distillate Oil - Small Sources	Low NOx Burner					√*							50%			1,180	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
ICI Boilers - Distillate Oil - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		1,090	2,490	2,490
ICI Boilers - Distillate Oil - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		2,780	2,780	3,570
ICI Boilers - Distillate Oil - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		3,470	4,640	4,640
ICI Boilers - Liquid Waste	Selective Catalytic Reduction (SCR)					√*			X				80%		1,480	1,480	1,910
ICI Boilers - Liquid Waste - Small Sources	Low NOx Burner					√*							50%			400	
ICI Boilers - Liquid Waste - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		1,120	1,120	1,080
ICI Boilers - Liquid Waste - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		1,940	2,580	2,580
ICI Boilers - LPG - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		2,780	2,780	3,570
ICI Boilers - LPG - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		1,090	2,490	2,490
ICI Boilers - LPG - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		3,470	4,640	4,640
ICI Boilers - LPG - Small Sources	Low NOx Burner					√*							50%			1,180	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
ICI Boilers - MSW/Stoker - Small Sources	Selective Non-Catalytic Reduction (SNCR) Urea Based					√*			X				55%			1,690	
ICI Boilers - Natural Gas - Large Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%			1,570	
ICI Boilers - Natural Gas - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		2,470	2,560	2,560
ICI Boilers - Natural Gas - Small Sources	Oxygen Trim + Water Injection					√*							65%			680	
ICI Boilers - Natural Gas - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		2,230	2,230	2,860
ICI Boilers - Natural Gas - Small Sources	Low NOx Burner					√*							50%			820	
ICI Boilers - Natural Gas - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		2,900	3,870	3,870
ICI Boilers - Process Gas - Small Sources	Oxygen Trim + Water Injection					√*							65%			680	
ICI Boilers - Process Gas - Small Sources	Low NOx Burner					√*							50%			820	
ICI Boilers - Process Gas - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		2,470	2,560	2,560
ICI Boilers - Process Gas - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		2,230	2,230	2,860

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
ICI Boilers - Residual Oil - Large Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%			1,050	
ICI Boilers - Residual Oil - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		1,480	1,480	1,910
ICI Boilers - Residual Oil - Small Sources	Low NOx Burner					√*							50%			400	
ICI Boilers - Residual Oil - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		1,940	2,580	2,580
ICI Boilers - Residual Oil - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		1,120	1,120	1,080
ICI Boilers - Wood/Bark/Stoker - Large Sources	Selective Non-Catalytic Reduction (SNCR) Urea Based					√*			X				55%			1,190	
ICI Boilers - Wood/Bark/Stoker - Small Sources	Selective Non-Catalytic Reduction (SNCR) Urea Based					√*			X				55%			1,440	
Industrial Coal Combustion	RACT to 25 tpy (LNB)					√*							21%			1,350	
Industrial Coal Combustion	RACT to 50 tpy (LNB)					√*							21%			1,350	
Industrial Incinerators	Selective Non-Catalytic Reduction (SNCR)					√*			X				45%			1,130	
Industrial Natural Gas Combustion	RACT to 50 tpy (LNB)					√*							31%			770	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Industrial Natural Gas Combustion	RACT to 25 tpy (LNB)					√*							31%			770	
Industrial Oil Combustion	RACT to 50 tpy (LNB)					√*							36%			1,180	
Industrial Oil Combustion	RACT to 25 tpy (LNB)					√*							36%			1,180	
In-Proc; Process Gas; Coke Oven/Blast Ovens	Low NOx Burner + Flue Gas Recirculation					√*							55%		1,430	3,190	3,190
In-Process Fuel Use - Bituminous Coal - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				40%			1,260	
In-Process Fuel Use; Natural Gas - Small Sources	Low NOx Burner					√*							50%			2,200	
In-Process Fuel Use; Residual Oil - Small Sources	Low NOx Burner					√*							37%			2,520	
In-Process; Bituminous Coal; Cement Kilns	Selective Non-Catalytic Reduction (SNCR) Urea Based					√*			X				50%			770	
In-Process; Bituminous Coal; Lime Kilns	Selective Non-Catalytic Reduction (SNCR) Urea Based					√*			X				50%			770	
In-Process; Process Gas; Coke Oven Gas	Low NOx Burner					√*							50%			2,200	
Internal Combustion Engines - Gas	L-E (Medium Speed)					√*							87%			380	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Internal Combustion Engines - Gas - Large Sources	Ignition Retard					√*							20%			550	
Internal Combustion Engines - Gas - Large Sources	Air/Fuel + Ignition Retard					√*							30%		150	460	460
Internal Combustion Engines - Gas - Large Sources	Air/Fuel Ratio Adjustment					√*							20%			380	
Internal Combustion Engines - Gas - Small Sources	Air/Fuel + Ignition Retard					√*							30%		270	1,440	1,440
Internal Combustion Engines - Gas - Small Sources	Air/Fuel Ratio Adjustment					√*							20%			1,570	
Internal Combustion Engines - Gas - Small Sources	Ignition Retard					√*							20%			1,020	
Internal Combustion Engines - Oil - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%			2,340	
Internal Combustion Engines - Oil - Small Sources	Ignition Retard					√*							25%			770	
Iron & Steel Mills - Annealing	Low NOx Burner (LNB) + SCR					√*			X				80%		1,320	1,720	1,720
Iron & Steel Mills - Annealing	Low NOx Burner + Flue Gas Recirculation					√*							60%		250	750	750
Iron & Steel Mills - Annealing	Selective Non-Catalytic Reduction (SNCR)					√*			X				60%			1,640	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Iron & Steel Mills - Annealing	Low NOx Burner					√*							50%			570	
Iron & Steel Mills - Annealing - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				85%			3,830	
Iron & Steel Mills - Annealing - Small Sources	Low NOx Burner (LNB) + Selective Catalytic Reduction (SCR)					√*			X				90%		3,720	4,080	4,080
Iron & Steel Mills - Galvanizing	Low NOx Burner + Flue Gas Recirculation					√*							60%		190	580	580
Iron & Steel Mills - Galvanizing	Low NOx Burner					√*							50%			490	
Iron & Steel Mills - Reheating	Low NOx Burner + Flue Gas Recirculation					√*							77%		150	380	380
Iron & Steel Mills - Reheating	Low NOx Burner					√*							66%			300	
Iron & Steel Mills - Reheating	Low Excess Air (LEA)					√*							13%			1,320	
Iron Production; Blast Furnaces; Blast Heating Stoves	Low NOx Burner + Flue Gas Recirculation					√*							77%			380	
Lime Kilns	Low NOx Burner					√*							30%			560	
Lime Kilns	Mid-Kiln Firing					√*							30%			460	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Medical Waste Incinerators	Selective Non-Catalytic Reduction (SNCR)					√*			X				45%			4,510	
Municipal Waste Combustors	Selective Non-Catalytic Reduction (SNCR)					√*			X				45%			1,130	
Natural Gas Production; Compressors - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				20%			1,651	
Nitric Acid Manufacturing - Small Sources	Extended Absorption					√*							95%			480	
Nitric Acid Manufacturing - Small Sources	Non-Selective Catalytic Reduction (NSCR)					√*			X				98%		510	550	710
Nitric Acid Manufacturing - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				97%			590	
Off-Highway Diesel Vehicles	Final Compression-Ignition (C-I) Engine Standards	√	√			√*	√			√		65%	72%	79%		N/A	
Off-Highway Diesel Vehicles	Final Compression-Ignition (C-I) Engine Standards	√	√			√*	√			√		49%	62%	75%		N/A	
Off-Highway Diesel Vehicles	Final Compression-Ignition (C-I) Engine Standards	√	√			√*	√			√		34%	45.5%	57%		N/A	
Off-Highway Diesel Vehicles	Final Compression-Ignition (C-I) Engine Standards	√	√			√*	√			√		21%	30%	59%		N/A	
Off-Highway Gasoline Vehicles	Large Spark-Ignition (S-I) Engine Standards	√	√			√*	√			√		-32%	33.5%	91%		N/A	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Off-Highway Gasoline Vehicles	Large Spark-Ignition (S-I) Engine Standards	√	√			√*	√			√		-26%	33.5%	93%		N/A	
Off-Highway Gasoline Vehicles	Large Spark-Ignition (S-I) Engine Standards	√	√			√*	√			√		-31%	29%	95%		N/A	
Off-Highway Gasoline Vehicles	Large Spark-Ignition (S-I) Engine Standards	√	√			√*	√			√		-26%	35.5%	77%		N/A	
Open Burning	Episodic Ban (Daily Only)					√*							100%			N/A	
Plastics Prod-Specific; (ABS) - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							55%		1,430	3,190	3,190
Process Heaters - Distillate Oil - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				75%			9,230	
Process Heaters - Distillate Oil - Small Sources	Low NOx Burner - Selective Non-Catalytic Reduction (SNCR)					√*			X				78%		3,620	3,620	3,830
Process Heaters - Distillate Oil - Small Sources	Ultra Low NOx Burner					√*							74%			2,140	
Process Heaters - Distillate Oil - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				60%			3,180	
Process Heaters - Distillate Oil - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							48%		4,250	4,250	19,540
Process Heaters - Distillate Oil - Small Sources	Low NOx Burner					√*							45%			3,470	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Process Heaters - Distillate Oil - Small Sources	Low NOx Burner (LNB) + Selective Catalytic Reduction (SCR)					√*			X				92%		9,120	9,120	15,350
Process Heaters - LPG - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				60%			3,180	
Process Heaters - LPG - Small Sources	Low NOx Burner (LNB) + Selective Catalytic Reduction (SCR)					√*			X				92%		9,120	9,120	15,350
Process Heaters - LPG - Small Sources	Low NOx Burner (LNB) + SNCR					√*			X				78%		3,620	3,620	3,830
Process Heaters - LPG - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				75%			9,230	
Process Heaters - LPG - Small Sources	Ultra Low NOx Burner					√*							74%			2,140	
Process Heaters - LPG - Small Sources	Low NOx Burner					√*							45%			3,470	
Process Heaters - LPG - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							48%		4,250	4,250	19,540
Process Heaters - Natural Gas - Small Sources	Ultra Low NOx Burner					√*							75%			1,500	
Process Heaters - Natural Gas - Small Sources	Low NOx Burner					√*							50%			2,200	
Process Heaters - Natural Gas - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							55%		3,190	3,190	15,580

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Process Heaters - Natural Gas - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				60%			2,850	
Process Heaters - Natural Gas - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				75%			12,040	
Process Heaters - Natural Gas - Small Sources	Low NOx Burner (LNB) + Selective Catalytic Reduction (SCR)					√*			X				88%		11,560	11,560	27,910
Process Heaters - Natural Gas - Small Sources	Low NOx Burner (LNB) + SNCR					√*			X				80%		3,520	3,520	6,600
Process Heaters - Other Fuel - Small Sources	Low NOx Burner (LNB) + SNCR					√*			X				75%		2,230	2,300	2,860
Process Heaters - Other Fuel - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				75%			5,350	
Process Heaters - Other Fuel - Small Sources	Ultra Low NOx Burner					√*							73%			1,290	
Process Heaters - Other Fuel - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				60%			1,930	
Process Heaters - Other Fuel - Small Sources	Low NOx Burner					√*							37%			2,520	
Process Heaters - Other Fuel - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							34%			3,490	
Process Heaters - Other Fuel - Small Sources	Low NOx Burner (LNB) + Selective Catalytic Reduction (SCR)					√*			X				91%		5,420	5,420	7,680

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Process Heaters - Process Gas - Small Sources	Low NOx Burner (LNB) + Selective Catalytic Reduction (SCR)					√*			X				88%		11,560	11,560	27,910
Process Heaters - Process Gas - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							55%		1,430	3,190	3,190
Process Heaters - Process Gas - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				60%			2,850	
Process Heaters - Process Gas - Small Sources	Ultra Low NOx Burner					√*							75%			1,500	
Process Heaters - Process Gas - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				75%			12,040	
Process Heaters - Process Gas - Small Sources	Low NOx Burner (LNB) +Selective Reduction SNCR					√*			X				80%		3,520	3,520	6,600
Process Heaters - Process Gas - Small Sources	Low NOx Burner					√*							50%			2,200	
Process Heaters - Residual Oil - Small Sources	Low NOx Burner (LNB) + Selective Catalytic Reduction (SCR)					√*			X				91%		5,420	5,420	7,680
Process Heaters - Residual Oil - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				75%			5,350	
Process Heaters - Residual Oil - Small Sources	Low NOx Burner (LNB) + SCR					√*			X				75%		2,230	2,300	2,860
Process Heaters - Residual Oil - Small Sources	Ultra Low NOx Burner					√*							73%			1,290	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Process Heaters - Residual Oil - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				60%			1,930	
Process Heaters - Residual Oil - Small Sources	Low NOx Burner					√*							37%			2,520	
Process Heaters - Residual Oil - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							34%			3,490	
Residential Natural Gas	Water Heater Replacement					√*							7%			N/A	
Residential Natural Gas	Water Heater + LNB Space Heaters					√*							7%			1,230	
Rich-Burn Stationary Reciprocating Internal Combustion Engines	Non-selective catalytic reduction					√*							90%			342	
Rich-Burn Stationary Reciprocating Internal Combustion Engines	Non-selective catalytic reduction					√*							90%			342	
Rich-Burn Stationary Reciprocating Internal Combustion Engines (RICE)	Non-selective catalytic reduction (NSCR)					√*	√			√			90%			342	
Sand/Gravel; Dryer - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							55%		1,430	3,190	3,190
Secondary Aluminum Production; Smelting Furnaces	Low NOx Burner					√*							50%			570	
Solid Waste Disposal; Government; Other	Selective Non-Catalytic Reduction (SNCR)					√*			X				45%			1,130	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Space Heaters - Distillate Oil - Small Sources	Low NOx Burner					√*							50%			1,180	
Space Heaters - Distillate Oil - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		3,470	4,640	4,640
Space Heaters - Distillate Oil - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		2,780	2,780	3,570
Space Heaters - Distillate Oil - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		1,090	2,490	2,490
Space Heaters - Natural Gas - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		2,900	3,870	3,870
Space Heaters - Natural Gas - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		2,230	2,230	2,860
Space Heaters - Natural Gas - Small Sources	Oxygen Trim + Water Injection					√*							65%			680	
Space Heaters - Natural Gas - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		2,470	2,560	2,560
Space Heaters - Natural Gas - Small Sources	Low NOx Burner					√*							50%			820	
Starch Manufacturing; Combined Operation - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							55%		1,430	3,190	3,190
Steel Foundries; Heat Treating	Low NOx Burner					√*							50%			570	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Steel Production; Soaking Pits	Low NOx Burner + Flue Gas Recirculation					√*							60%		250	750	750
Sulfate Pulping - Recovery Furnaces - Small Sources	Low NOx Burner + Flue Gas Recirculation					√*							60%		2,470	2,560	2,560
Sulfate Pulping - Recovery Furnaces - Small Sources	Selective Catalytic Reduction (SCR)					√*			X				80%		2,230	2,230	2,860
Sulfate Pulping - Recovery Furnaces - Small Sources	Low NOx Burner					√*							50%			820	
Sulfate Pulping - Recovery Furnaces - Small Sources	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%		2,900	3,870	3,870
Sulfate Pulping - Recovery Furnaces - Small Sources	Oxygen Trim + Water Injection					√*							65%			680	
Surface Coat Oper; Coating Oven Htr; Nat Gas - Small Sources	Low NOx Burner					√*			X				50%			2,200	
Utility Boiler - Coal/Tangential	Low NOx Coal-and-Air Nozzles with Close-Coupled and Separated Overfire Air (LNC3)					√*							58%			N/A	
Utility Boiler - Coal/Tangential	Low NOx Coal-and-Air Nozzles with cross-Coupled Overfire Air (LNC1)					√*							43%			N/A	
Utility Boiler - Coal/Tangential	Low NOx Coal-and-Air Nozzles with separated Overfire Air (LNC2)					√*							48%			N/A	
Utility Boiler - Coal/Tangential	Low NOx Coal-and-Air Nozzles with Close-Coupled and Separated Overfire Air (LNC3)					√*							53%			N/A	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Utility Boiler - Coal/Tangential	Low NOx Coal-and-Air Nozzles with separated Overfire Air (LNC2)					√*							38%			N/A	
Utility Boiler - Coal/Tangential	Low NOx Coal-and-Air Nozzles with cross-Coupled Overfire Air (LNC1)					√*							33%			N/A	
Utility Boiler - Coal/Tangential	Selective Catalytic Reduction (SCR)					√*			X		√		90% (Hg 95%)			N/A	
Utility Boiler - Coal/Tangential	Selective Non-Catalytic Reduction (SNCR)					√*			X				35%			N/A	
Utility Boiler - Coal/Tangential	Natural Gas Reburn (NGR)					√*							50%			N/A	
Utility Boiler - Coal/Wall	Low NOx Burner with Overfire Air					√*							56%			N/A	
Utility Boiler - Coal/Wall	Low NOx Burner with Overfire Air					√*							55%			N/A	
Utility Boiler - Coal/Wall	Low NOx Burner without Overfire Air					√*							40%			N/A	
Utility Boiler - Coal/Wall	Low NOx Burner without Overfire Air					√*							41			N/A	
Utility Boiler - Coal/Wall	Selective Non-Catalytic Reduction (SNCR)					√*			X				35%			N/A	
Utility Boiler - Coal/Wall	Selective Catalytic Reduction (SCR)					√*			X				90%			N/A	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Utility Boiler - Coal/Wall	Natural Gas Reburn (NGR)					√*							50%			N/A	
Utility Boiler - Cyclone	Natural Gas Reburn (NGR)					√*							50%			N/A	
Utility Boiler - Cyclone	Selective Non-Catalytic Reduction (SNCR)					√*			X				35%			N/A	
Utility Boiler - Cyclone	Selective Catalytic Reduction (SCR)					√*			X				80%			N/A	
Utility Boiler - Oil-Gas/Tangential	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%			N/A	
Utility Boiler - Oil-Gas/Tangential	Natural Gas Reburn (NGR)					√*							50%			N/A	
Utility Boiler - Oil-Gas/Tangential	Selective Catalytic Reduction (SCR)					√*			X				80%			N/A	
Utility Boiler - Oil-Gas/Wall	Selective Non-Catalytic Reduction (SNCR)					√*			X				50%			N/A	
Utility Boiler - Oil-Gas/Wall	Natural Gas Reburn (NGR)					√*							50%			N/A	
Utility Boiler - Oil-Gas/Wall	Selective Catalytic Reduction (SCR)					√*			X				80%			N/A	
Agricultural Burning	Bale Stack/Propane Burning	√	√*	√	√							49%	63%	63%		2,591	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Agricultural Tilling	Soil Conservation Plans	√	√	√	√								11.7%			138	
Asphalt Manufacture	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Asphalt Manufacture	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Asphalt Manufacture	Paper/Nonwoven Filters - Cartridge Collector Type	√	√*	√	√								99%		85	147	256
Asphalt Manufacture	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Asphalt Manufacture	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Asphalt Manufacture	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Beef Cattle Feedlots	Watering	√	√*	√	√								50%			307	
Chemical Manufacture	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Chemical Manufacture	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Chemical Manufacture	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Commercial Institutional Boilers - Coal	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Commercial Institutional Boilers - Coal	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Commercial Institutional Boilers - Coal	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Commercial Institutional Boilers - Coal	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Commercial Institutional Boilers - Coal	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Commercial Institutional Boilers - Natural Gas	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Commercial Institutional Boilers - Oil	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Commercial Institutional Boilers - Oil	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Commercial Institutional Boilers - Oil	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Commercial Institutional Boilers - Solid Waste	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Commercial Institutional Boilers - Solid Waste	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Commercial Institutional Boilers - Wood	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Commercial Institutional Boilers - Wood	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Commercial Institutional Boilers - Wood/Bark	Dry ESP-Wire Plate Type	√	√*	√	√								90%		40	110	250
Commercial Institutional Boilers - Wood/Bark	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								80%		53	148	337
Commercial Institutional Boilers - Wood/Bark	Fabric Filter (Pulse Jet Type)	√	√*	√	√								80%		42	117	266
Construction Activities	Dust Control Plan	√	√*	√	√								62.5%			3,600	
Conveyorized Charbroilers	Catalytic Oxidizer	√*	√*	√	√		√					80%	83%	90%		2,966	
Conveyorized Charbroilers	ESP for Commercial Cooking	√*	√*	√	√							99%	99%	99%		7,000	
Electric Generation - Coke	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Electric Generation - Coke	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Electric Generation - Bagasse	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Electric Generation - Bagasse	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Electric Generation - Coal	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Electric Generation - Coal	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Electric Generation - Coal	Two plate ESP upgrade	√*	√	√	√								67%			N/A	
Electric Generation - Coal	Indigo Agglomerator	√*	√	√	√								40%			N/A	
Electric Generation - Coal	One plate ESP upgrade	√*	√	√	√								44%			N/A	
Electric Generation - Liquid Waste	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Electric Generation - Liquid Waste	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Electric Generation - LPG	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Electric Generation - LPG	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Electric Generation - Natural Gas	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Electric Generation - Natural Gas	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Electric Generation - Oil	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Electric Generation - Oil	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Electric Generation - Solid Waste	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Electric Generation - Solid Waste	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Electric Generation - Wood	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Electric Generation - Wood	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Fabricated Metal Products - Abrasive Blasting	Paper/Nonwoven Filters - Cartridge Collector Type	√	√*	√	√								99%		85	142	256
Fabricated Metal Products - Welding	Paper/Nonwoven Filters - Cartridge Collector Type	√	√*	√	√								99%		85	142	256
Ferrous Metals Processing - Coke	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Ferrous Metals Processing - Coke	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Ferrous Metals Processing - Coke	Venturi Scrubber	√	√*	√	√								93%		75	751	2,100
Ferrous Metals Processing - Coke	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Ferrous Metals Processing - Coke	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Ferrous Metals Processing - Ferroalloy Production	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Ferrous Metals Processing - Ferroalloy Production	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Ferrous Metals Processing - Ferroalloy Production	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Ferrous Metals Processing - Ferroalloy Production	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Ferrous Metals Processing - Ferroalloy Production	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Ferrous Metals Processing - Gray Iron Foundries	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Ferrous Metals Processing - Gray Iron Foundries	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Ferrous Metals Processing - Gray Iron Foundries	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Ferrous Metals Processing - Gray Iron Foundries	Impingement-Plate Scrubber	√	√*	√	√								64%		46	431	1,200
Ferrous Metals Processing - Gray Iron Foundries	Venturi Scrubber	√	√*	√	√								94%		76	751	2,100
Ferrous Metals Processing - Gray Iron Foundries	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Ferrous Metals Processing - Iron & Steel Production	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Ferrous Metals Processing - Iron & Steel Production	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Ferrous Metals Processing - Iron and Steel Production	Sinter Cooler	√*	√	√	√								99%			5,000	
Ferrous Metals Processing - Iron and Steel Production	Capture Hood Vented to a Baghouse	√*	√	√	√								85%			N/A	
Ferrous Metals Processing - Iron and Steel Production	Secondary Capture and Control System	√*	√	√	√								85%			N/A	
Ferrous Metals Processing - Iron and Steel Production	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Ferrous Metals Processing - Iron and Steel Production	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Ferrous Metals Processing - Iron and Steel Production	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Ferrous Metals Processing - Iron and Steel Production	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Ferrous Metals Processing - Iron and Steel Production	Venturi Scrubber	√	√*	√	√								73%		76	751	2,100
Ferrous Metals Processing - Iron and Steel Production	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Ferrous Metals Processing - Other	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Ferrous Metals Processing - Other	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Ferrous Metals Processing - Steel Foundries	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Ferrous Metals Processing - Steel Foundries	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Ferrous Metals Processing - Steel Foundries	Venturi Scrubber	√	√*	√	√								73%		76	751	2,100
Ferrous Metals Processing - Steel Foundries	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Ferrous Metals Processing - Steel Foundries	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Ferrous Metals Processing - Steel Foundries	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Grain Milling	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Grain Milling	Paper/Nonwoven Filters - Cartridge Collector Type	√	√*	√	√								99%		85	142	256
Grain Milling	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Highway Vehicles - Gasoline Engine	RFG and High Enhanced I/M Program					√	√*			√		-9.1%	11.4%	31.9%	484	16,164	
Highway Vehicles - Heavy Duty Diesel Engines	Voluntary Diesel Retrofit Program: Diesel Particulate Filter	√	√*				√	√		√			61.99%			727,689	
Highway Vehicles - Heavy Duty Diesel Engines	Voluntary Diesel Retrofit Program: Diesel Oxidation Catalyst	√	√*				√	√		√			24.01%			167,640	
Highway Vehicles - Heavy Duty Diesel Engines	Voluntary Diesel Retrofit Program: Biodiesel Fuel	√	√*				√			√			7%			209,913	
Industrial Boilers - Coal	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Industrial Boilers - Coal	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Industrial Boilers - Coal	Venturi Scrubber	√	√*	√	√								82%		76	751	2,100
Industrial Boilers - Coal	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Industrial Boilers - Coal	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Industrial Boilers - Coal	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Industrial Boilers - Coke	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Industrial Boilers - Coke	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Industrial Boilers - Liquid Waste	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Industrial Boilers - Oil	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Industrial Boilers - Oil	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Industrial Boilers - Oil	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Industrial Boilers - Oil	Venturi Scrubber	√	√*	√	√								92%		76	751	2,100
Industrial Boilers - Solid Waste	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Industrial Boilers - Solid Waste	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Industrial Boilers - Wood	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Industrial Boilers - Wood	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Industrial Boilers - Wood	Venturi Scrubber	√	√*	√	√								93%		76	751	2,100
Industrial Boilers - Wood	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Industrial Boilers - Wood	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Industrial Boilers - Wood	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Mineral Products - Cement Manufacture	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Mineral Products - Cement Manufacture	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Mineral Products - Cement Manufacture	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Mineral Products - Cement Manufacture	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Mineral Products - Cement Manufacture	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Mineral Products - Cement Manufacture	Paper/Nonwoven Filters - Cartridge Collector Type	√	√*	√	√								99%		85	142	256
Mineral Products - Cement Manufacture	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Mineral Products - Coal Cleaning	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Mineral Products - Coal Cleaning	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Mineral Products - Coal Cleaning	Venturi Scrubber	√	√*	√	√								99%		76	751	2,100
Mineral Products - Coal Cleaning	Paper/Nonwoven Filters - Cartridge Collector Type	√	√*	√	√								99%		85	142	256
Mineral Products - Coal Cleaning	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Mineral Products - Coal Cleaning	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Mineral Products - Coal Cleaning	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Mineral Products - Other	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Mineral Products - Other	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Mineral Products - Other	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Mineral Products - Other	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550
Mineral Products - Other	Paper/Nonwoven Filters - Cartridge Collector Type	√	√*	√	√								99%		85	145	256
Mineral Products - Other	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Mineral Products - Other	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Mineral Products - Other	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Mineral Products - Stone Quarrying & Processing	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Mineral Products - Stone Quarrying & Processing	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Mineral Products - Stone Quarrying and Processing	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Mineral Products - Stone Quarrying and Processing	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Mineral Products - Stone Quarrying and Processing	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Mineral Products - Stone Quarrying and Processing	Paper/Nonwoven Filters - Cartridge Collector Type	√	√*	√	√								99%		85	142	256
Mineral Products - Stone Quarrying and Processing	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550
Mineral Products - Stone Quarrying and Processing	Venturi Scrubber	√	√*	√	√								95%		76	751	2,100
Mineral Products - Stone Quarrying and Processing	Fabric Filter (Pulse Jet Type)	√	√*	√	√								99%		42	117	266
Municipal Waste Incineration	Dry ESP-Wire Plate Type	√	√*	√									98%		40	110	250
Non-Ferrous Metals Processing - Aluminum	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Non-Ferrous Metals Processing - Aluminum	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Non-Ferrous Metals Processing - Aluminum	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Non-Ferrous Metals Processing - Aluminum	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Non-Ferrous Metals Processing - Aluminum	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550
Non-Ferrous Metals Processing - Aluminum	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Non-Ferrous Metals Processing - Copper	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Non-Ferrous Metals Processing - Copper	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Non-Ferrous Metals Processing - Copper	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Non-Ferrous Metals Processing - Copper	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550
Non-Ferrous Metals Processing - Copper	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Non-Ferrous Metals Processing - Copper	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Non-Ferrous Metals Processing - Lead	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Non-Ferrous Metals Processing - Lead	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Non-Ferrous Metals Processing - Lead	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Non-Ferrous Metals Processing - Lead	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550
Non-Ferrous Metals Processing - Lead	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Non-Ferrous Metals Processing - Lead	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Non-Ferrous Metals Processing - Other	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Non-Ferrous Metals Processing - Other	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Non-Ferrous Metals Processing - Other	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	1,260	303
Non-Ferrous Metals Processing - Other	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Non-Ferrous Metals Processing - Other	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550
Non-Ferrous Metals Processing - Other	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Non-Ferrous Metals Processing - Zinc	CEM Upgrade and Increased Monitoring Frequency of PM Controls	√*	√*										7.7%			5,200	
Non-Ferrous Metals Processing - Zinc	Increased Monitoring Frequency (IMF) of PM Controls	√*	√*	√	√								6.5%			620	
Non-Ferrous Metals Processing - Zinc	Fabric Filter (Mech. Shaker Type)	√	√*	√	√								99%		37	126	303
Non-Ferrous Metals Processing - Zinc	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Non-Ferrous Metals Processing - Zinc	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√								99%		53	148	337
Non-Ferrous Metals Processing - Zinc	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550
Nonroad Diesel Engines	Heavy Duty Retrofit Program	√	√*	√	√								1%			9,500	
Paved Roads	Vacuum Sweeping	√	√*	√	√								50.5%			485	
Prescribed Burning	Increase Fuel Moisture	√	√*	√	√								50%			2,617	
Residential Home Heating	Switch to Low Sulfur Fuel	√*	√*			√		√					75%			2,350	
Residential Wood Combustion	Education and Advisory Program	√	√*	√	√								50%			1,320	
Residential Wood Stoves	NSPS compliant Wood Stoves	√*	√*										98%			2,000	
Unpaved Roads	Hot Asphalt Paving	√	√*	√	√								67.5%			537	
Unpaved Roads	Chemical Stabilization	√	√*	√									37.5%			2,753	
Utility Boilers - Coal	Dry ESP-Wire Plate Type	√	√*	√	√						√	(Hg 3%)	98% (Hg 20%)	(Hg 36%)	40	110	250

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Utility Boilers - Coal	Fabric Filter (Mech. Shaker Type)	√	√*	√	√						√		99.5%		37	126	303
Utility Boilers - Coal	Fabric Filter (Pulse Jet Type)	√	√*	√	√						√		99%		42	117	266
Utility Boilers - Coal	Fabric Filter	√	√*	√	√						√		95% (Hg 80%)			N/A	
Utility Boilers - Coal	Fabric Filter (Reverse-Air Cleaned Type)	√	√*	√	√						√		99%		53	148	337
Utility Boilers - Gas/Oil	Fabric Filter	√	√*	√	√						√		95%			N/A	
Wood Pulp & Paper	Wet ESP - Wire Plate Type	√	√*	√	√								99%		55	220	550
Wood Pulp & Paper	Dry ESP-Wire Plate Type	√	√*	√	√								98%		40	110	250
Bituminous/Subbituminous Coal	Flue Gas Desulfurization							√*					90%			N/A	
Bituminous/Subbituminous Coal	Flue Gas Desulfurization							√*					90%			N/A	
Bituminous/Subbituminous Coal (Industrial Boilers)	Spray Dryer Absorber							√*					90%		804	1,341	1,973
Bituminous/Subbituminous Coal (Industrial Boilers)	In-duct Dry Sorbent Injection							√*					40%		1,111	1,526	2,107

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Bituminous/Subbituminous Coal (Industrial Boilers)	Wet Flue Gas Desulfurization							√*					90%		1,027	1,536	1,980
By-Product Coke Manufacturing	Vacuum Carbonate Plus Sulfur Recovery Plant							√*					90%			N/A	
Inorganic Chemical Manufacture Operations	Flue Gas Desulfurization							√*					90%			N/A	
In-process Fuel Use - Bituminous Coal	Flue Gas Desulfurization							√*					90%			N/A	
Lignite (Industrial Boiler)	In-duct Dry Sorbent Injection							√*					40%		1,111	1,526	2,107
Lignite (Industrial Boiler)	Spray Dryer Absorber							√*					90%		804	1,341	1,973
Lignite (Industrial Boiler)	Wet Flue Gas Desulfurization							√*					90%		1,027	1,536	1,980
Lignite (Industrial Boilers)	Flue Gas Desulfurization							√*					90%			N/A	
Mineral Products Industry	Flue Gas Desulfurization							√*					90%			N/A	
Petroleum Industry	Flue Gas Desulfurization (FGD)							√*					90%			N/A	
Primary Lead Smelters - Sintering	Dual Absorption							√*					99%			N/A	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Primary Metals Industry	Flue Gas Desulfurization							√*					90%			N/A	
Primary Zinc Smelters - Sintering	Dual Absorption							√*					99%			N/A	
Process Heaters (Oil and Gas Production)	Flue Gas Desulfurization							√*					90%			N/A	
Pulp and Paper Industry (Sulfate Pulping)	Flue Gas Desulfurization							√*					90%			N/A	
Residual Oil (Commercial/Institutional Boilers)	Wet Flue Gas Desulfurization							√*					90%		2,295	3,489	4,524
Residual Oil (Commercial/Institutional Boilers)	Flue Gas Desulfurization							√*					90%			N/A	
Residual Oil (Industrial Boilers	Flue Gas Desulfurization							√*					90%			N/A	
Secondary Metal Production	Flue Gas Desulfurization							√*					90%			N/A	
Steam Generating Unit-Coal/Oil	Flue Gas Desulfurization							√*					90%			N/A	
Sulfur Recovery Plants - Elemental Sulfur	Amine Scrubbing + Flue Gas Desulfurization							√*					99.8%			N/A	
Sulfur Recovery Plants - Elemental Sulfur	Amine Scrubbing + Flue Gas Desulfurization							√*					99.7%			N/A	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Sulfur Recovery Plants - Elemental Sulfur	Amine Scrubbing							√*					98.4%			N/A	
Sulfur Recovery Plants - Elemental Sulfur	Amine Scrubbing							√*					97.8%			N/A	
Sulfur Recovery Plants - Elemental Sulfur	Amine Scrubbing + Flue Gas Desulfurization							√*					99.8%			N/A	
Sulfur Recovery Plants - Elemental Sulfur	Amine Scrubbing							√*					97.1%			N/A	
Sulfuric Acid Plants - Contact Absorbers	Increase Absorption Efficiency from Existing to NSPS Level (99.7%) + Flue Gas Desulfurization							√*					75%			N/A	
Sulfuric Acid Plants - Contact Absorbers	Increase Absorption Efficiency from Existing to NSPS Level (99.7%)							√*					95%			N/A	
Sulfuric Acid Plants - Contact Absorbers	Increase Absorption Efficiency from Existing to NSPS Level (99.7%) + Flue Gas Desulfurization							√*					90%			N/A	
Sulfuric Acid Plants - Contact Absorbers	Increase Absorption Efficiency from Existing to NSPS Level (99.7%)							√*					90%			N/A	
Sulfuric Acid Plants - Contact Absorbers	Increase Absorption Efficiency from Existing to NSPS Level (99.7%)							√*					85%			N/A	
Sulfuric Acid Plants - Contact Absorbers	Increase Absorption Efficiency from Existing to NSPS Level (99.7%) + Flue Gas Desulfurization							√*					95%			N/A	
Sulfuric Acid Plants - Contact Absorbers	Increase Absorption Efficiency from Existing to NSPS Level (99.7%)							√*					75%			N/A	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Sulfuric Acid Plants - Contact Absorbers	Flue Gas Desulfurization							√*					90%			N/A	
Sulfuric Acid Plants - Contact Absorbers	Increase Absorption Efficiency from Existing to NSPS Level (99.7%) + Flue Gas Desulfurization							√*					85%			N/A	
Utility Boilers - Coal-Fired	Repowering to IGCC					√		√*			√		99%			N/A	
Utility Boilers - Coal-Fired	Coal Washing	√	√					√*			√		40%		70	320	563
Utility Boilers - Coal-Fired	Fuel Switching - High-Sulfur Coal to Low-Sulfur Coal	√	√					√*					60%		113	140	167
Utility Boilers - High Sulfur Content	Flue Gas Desulfurization (Wet Scrubber Type)							√*			√	(Hg 29%)	90% (Hg 64%)	(Hg 98%)		N/A	
Utility Boilers - Medium Sulfur Content	Flue Gas Desulfurization (Wet Scrubber Type)							√*			√	(Hg 29%)	90% (Hg 64%)	(Hg 98%)		N/A	
Utility Boilers - Very High Sulfur Content	Flue Gas Desulfurization (Wet Scrubber Type)							√*			√		90%			N/A	
Adhesives - Industrial	SCAQMD Rule 1168						√*						73%			2,202	
Aircraft Surface Coating	MACT Standard						√*						60%			165	
Architectural Coatings	OTC AIM Coating Rule						√*						55%			6,628	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Architectural Coatings	AIM Coating Federal Rule						√*						20%			228	
Architectural Coatings	South Coast Phase I						√*						34%		3,300	1,443	4,600
Architectural Coatings	South Coast Phase III						√*						73%			10,059	
Architectural Coatings	South Coast Phase II						√*						47%			4,017	
AREA	OTC Mobile Equipment Repair and Refinishing Rule						√*						61%			2,534	
AREA	OTC Mobile Equipment Repair and Refinishing Rule						√*						61%			2,534	
AREA	OTC Solvent Cleaning Rule						√*						66%			1,400	
AREA	OTC Consumer Products Rule						√*						39.2%			1,032	
AREA	OTC Mobile Equipment Repair and Refinishing Rule						√*						61%			2,534	
AREA	OTC Mobile Equipment Repair and Refinishing Rule						√*						61%			2,534	
AREA	OTC Consumer Products Rule						√*						39.2%			1,032	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Automobile Refinishing	California FIP Rule (VOC content & TE)						√*						89%			7,200	
Automobile Refinishing	CARB BARCT Limits						√*						47%			750	
Automobile Refinishing	Federal Rule						√*						37%			118	
Bakery Products	Incineration >100,000 lbs bread						√*						39.9%			1,470	
Commercial Adhesives	Federal Consumer Solvents Rule						√*						25%			232	
Commercial Adhesives	CARB Long-Term Limits						√*						85%			2,880	
Commercial Adhesives	CARB Mid-Term Limits						√*						55%			2,192	
Consumer Solvents	CARB Mid-Term Limits						√*						55%			2,192	
Consumer Solvents	Federal Consumer Solvents Rule						√*						25%			232	
Consumer Solvents	CARB Long-Term Limits						√*						85%			2,880	
Cutback Asphalt	Switch to Emulsified Asphalts						√*						100%			15	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Electrical/Electronic Coating	SCAQMD Rule						√*						70%			5,976	
Electrical/Electronic Coating	MACT Standard						√*						36%			5,000	
Fabric Printing, Coating and Dyeing	Permanent Total Enclosure (PTE)						√*						97%			N/A	
Flexographic Printing	Permanent Total Enclosure (PTE)						√*						95			9,947	
Graphic Arts	Use of Low or No VOC Materials						√*						65%		3,500	4,150	4,800
Highway Vehicles - Gasoline Engine	Federal Reformulated Gasoline (RFG)					X	√*			√		0%	7.65%	15.3%	2,498	25,093	
Highway Vehicles - Light Duty Gasoline Engines	Basic Inspection and Maintenance Program	√	√			√	√*	√	√	√			NA			N/A	
Industrial Maintenance Coating	South Coast Phase III						√*						73%			10,059	
Industrial Maintenance Coating	AIM Coating Federal Rule						√*						20%			228	
Industrial Maintenance Coating	South Coast Phase I						√*						34%		3,300	1,443	4,600
Industrial Maintenance Coating	South Coast Phase II						√*						47%			4,017	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Machinery, Equipment, and Railroad Coating	SCAQMD Limits						√*						55.2%			2,027	
Marine Surface Coating (Shipbuilding)	Add-On Controls						√*						90%			8,937	
Marine Surface Coating (Shipbuilding)	MACT Standard						√*						24%			2,090	
Metal Can Surface Coating Operations	Permanent Total Enclosure (PTE)						√*						95			8,469	
Metal Coil & Can Coating	MACT Standard						√*						36%			1,000	
Metal Coil & Can Coating	Incineration						√*						90%			8,937	
Metal Coil & Can Coating	BAAQMD Rule 11 Amended						√*						42%			2,007	
Metal Furniture Surface Coating Operations	Permanent Total Enclosure (PTE)						√*						95			19,321	
Metal Furniture, Appliances, Parts	SCAQMD Limits						√*						55.2%			2,027	
Metal Furniture, Appliances, Parts	MACT Standard						√*						36%			1,000	
Miscellaneous Metal Products Coatings	MACT Standard						√*						36%			1,000	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Motor Vehicle Coating	Incineration						√*						90%			8,937	
Motor Vehicle Coating	MACT Standard						√*						36%			118	
Municipal Solid Waste Landfill	Gas Collection (SCAQMD/BAAQMD)						√*						70%			700	
Nonroad Gasoline Engines	Federal Reformulated Gasoline						√*						1.4%		440	4,854	9,250
Off-Highway Vehicles: All Terrain Vehicles (ATVs)	Recreational Gasoline ATV Standards	√	√			√	√*			√		33%	64%	95%		N/A	
Off-Highway Vehicles: All Terrain Vehicles (ATVs)	Recreational Gasoline ATV Standards	√	√			√	√*			√		27%	40%	73%		N/A	
Off-Highway Vehicles: All Terrain Vehicles (ATVs)	Recreational Gasoline ATV Standards	√	√			√	√*			√		14%	24%	34%		N/A	
Off-Highway Vehicles: All Terrain Vehicles (ATVs)	Recreational Gasoline ATV Standards	√	√			√	√*			√		33%	65%	97%		N/A	
Off-Highway Vehicles: Motorcycles	Recreational Gasoline Off-Highway Motorcycle Standards	√	√			√	√*			√		12%	32%	52%		N/A	
Off-Highway Vehicles: Motorcycles	Recreational Gasoline Off-Highway Motorcycle Standards	√	√			√	√*			√		5%	12.5%	20%		N/A	
Off-Highway Vehicles: Motorcycles	Recreational Gasoline Off-Highway Motorcycle Standards	√	√			√	√*			√		10%	25%	40%		N/A	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Off-Highway Vehicles: Motorcycles	Recreational Gasoline Off-Highway Motorcycle Standards	√	√			√	√*			√		12%	31%	50%		N/A	
Off-Highway Vehicles: Snowmobiles	Recreational Gasoline Snowmobile Standards	√	√			X	√*			√			62%			N/A	
Off-Highway Vehicles: Snowmobiles	Recreational Gasoline Snowmobile Standards	√	√			X	√*			√			20%			N/A	
Off-Highway Vehicles: Snowmobiles	Recreational Gasoline Snowmobile Standards	√	√			X	√*			√			69%			N/A	
Off-Highway Vehicles: Snowmobiles	Recreational Gasoline Snowmobile Standards	√	√			X	√*			√			45%			N/A	
Oil and Natural Gas Production	Equipment and Maintenance						√*						37%			317	
Oil and Natural Gas Production - Fugitive Emissions	SCAQMD Proposed Rule 1148.1 - Fugitive Emissions						√*						14%			2,483	
Open Top Degreasing	SCAQMD 1122 (VOC content limit)						√*						76%			1,248	
Open Top Degreasing	Title III MACT Standard						√*						31%			-69	
Open Top Degreasing	Airtight Degreasing System						√*						98%			9,789	
Paper and other Web Coating Operations	Permanent Total Enclosure (PTE)						√*						95			1,503	

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Paper Surface Coating	Incineration						√*						78%			4,776	
Pesticide Application	Reformulation - FIP Rule						√*						20%			9,300	
Portable Gasoline Containers	OTC Portable Gas Container Rule						√*						33%			581	
Product and Packaging Rotogravure and Screen Printing	Permanent Total Enclosure (PTE)						√*						95			12,770	
Publication Rotogravure Printing	Permanent Total Enclosure (PTE)						√*						95			2,422	
Rubber and Plastics Manufacturing	SCAQMD - Low VOC						√*						60%			1,020	
Stage II Service Stations	Low Pressure/Vacuum Relief Valve						√*						91.6%		930	1,080	1,230
Stage II Service Stations - Underground Tanks	Low Pressure/Vacuum Relief Valve						√*						73%		930	1,080	1,230
Traffic Markings	South Coast Phase III						√*						73%			1,059	
Traffic Markings	AIM Coating Federal Rule						√*						20%			228	
Traffic Markings	South Coast Phase I						√*						34%		8,600	1,443	12,800

Source Category	Control Measure Name	Pollutant(s) Affected √ = pollutant reductio, X = pollutant increase, * = major pollutant										Control Efficiency (% from baseline)			Average Annual Cost Effectiveness ($/ton primary pollutant)		
		PM2.5	PM10	EC	OC	NOx	VOC	SO2	NH3	CO	Hg	Low	Typical	High	Low	Typical	High
Traffic Markings	South Coast Phase II						√*						47%			4,017	
Wood Furniture Surface Coating	New CTG						√*						47%		462	967	22,100
Wood Furniture Surface Coating	Add-On Controls						√*					67%	75%	98%	468	20,000	22,100
Wood Furniture Surface Coating	MACT Standard						√*						30%			446	
Wood Product Surface Coating	Incineration						√*						86%			4,202	
Wood Product Surface Coating	SCAQMD Rule 1104						√*						53%			881	
Wood Product Surface Coating	MACT Standard						√*						30%			446	

APPENDIX C: ONROAD MOBILE CONTROL MEASURES

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INTRODUCTION

The focus of AirControlNET has primarily been to evaluate control measures for stationary sources (i.e., EGUs, nonEGUs, and area sources) and estimate emissions reduction and the associated costs. However, in order to gain a more complete picture of available control measures for policy consideration and for conducting "what if" scenarios we found it necessary to include control measures available for onroad and nonroad mobile sources. Thus, the purpose of this appendix is to document the development and implementation of a capability within AirControlNET to evaluate onroad mobile source control measures, i.e., estimate emission reductions and costs from a baseline emissions inventory. For onroad mobile sources, we conducted model simulations of MOBILE 6.2 to develop control measure data for inclusion into AirControlNET. This initial effort focused on including only data associated with the implementation of the following three programs for the years 2010, 2020, and 2030:

1) Tier 2/Gasoline Sulfur Final Rulemaking (Provide Federal Register citation from 2/10/2000 and place in references)

2) Heavy Duty Diesel Engine and Fuel Standards (provide Federal Register citation from 1/18/2001 and place in references)

3) Voluntary Diesel Retrofit programs(i.e., particulate filters, oxidation catalyst, SCR, and biodiesel fuel)

In order to develop additional mobile source inputs using the methods described below, the MOBILE 6.2 model would need to be run to estimate the emissions reductions. EPA is currently developing the National Mobile Inventory Model (NMIM) which is a consolidated emissions modeling system for mobile and nonroad emissions inventory development. It is expected that at some time in the future, NMIM will replace these models. However, as currently configured, AirControlNET is not connected to NMIM..

This appendix begins with a detailed example for the Tier 2 program to illustrate the data and methods used in developing the emission reductions and costs associated with the control strategy. This example is followed by an overview of the steps and assumptions made for estimating these data for the Tier 2 Rulemaking, HD Engine/Fuel Standards, and Voluntary Diesel retrofit programs. Future efforts are expected to incorporate additional federal programs as well as other control options that are technically feasible to achieve criteria air pollutant reductions from onroad mobile sources now and in the future.

TIER 2 EXAMPLE

This example is included in order to illustrate the steps followed in developing emissions reductions and costs for each of the onroad control measures. The necessary steps are as follows:

1) Pick a representative scenario condition (e.g., temperature, RVP, speed, etc.).

2) Calculate MOBILE6.2 emission factors for the base year (1999) by model year and vehicle type at the conditions selected in Step 1. Using the default fleet information from MOBILE6.2, calculate a weighted average emission factor for each vehicle type.

3) Calculate MOBILE6.2 emission factors by applying a given emission standard or control measure for each model year and vehicle type for all vehicle types that might be affected by the selected control measure at the conditions selected in Step 1. This must be modeled carefully so that each of the 25 model years included in the MOBILE6.2 output are modeled with full implementation of the selected control measure.

4) Determine the degree of implementation of the new control measure (e.g., 25 percent of vehicles, simulate 2020 phase-in, etc.).

5) Combine emission factors by model year from Steps 2 and 3 such that the appropriate model years or vehicle ages receive the selected control measures. Using the default fleet information from MOBILE6.2, calculate the weighted average emission factor for each affected vehicle type.

6) Calculate the percent difference between the Step 5 weighted average emission factor and the Step 2 weighted average emission factor for each vehicle type.

7) Apply the percent difference estimated in Step 6 to the baseline AirControlNET emissions at the county/vehicle type level of detail.

For this example, in Step 1, the representative conditions selected were those typical of a summer day. A minimum daily temperature of 70ºF and a maximum daily temperature of 90ºF were chosen. The RVP was set to 8.7 psi. This is the typical summertime RVP level, based on the Phase II RVP regulations, for a majority of the country in 1999. Southern nonattainment areas, reformulated gasoline areas, and other areas implementing low RVP programs would have lower RVP levels. An average speed of 35 mph on arterial roadways was modeled.

Under Step 2, a MOBILE6.2 input file was developed for 1999 at the conditions described above. This input file is shown in Figure C-1.

After running MOBILE6.2 with the input file shown in Figure C-1, the emission factors were obtained in the database output format. For each of the 25 model years included in the database output file, two emission factors were obtained–one representing the exhaust running emission factor and one representing the exhaust engine start emission factor. Both emission factors are expressed in grams per mile and can be added for a given model year to obtain the total NO_x emission factor for that model year. These emission factors were totaled by model year, with the results shown in Table C-1. In Table C-1, the columns labeled model year, vehicle age, miles traveled per day, registration distribution fraction, and fuel economy are obtained directly from the MOBILE6.2 database output. The LDGV NO_x emission factor column was obtained by adding the MOBILE6.2 emission factors for exhaust running and engine start emissions within a model year. The column labeled weighted NO_x emission factor was calculated by multiplying the LDGV NO_x emission factor by the miles traveled per day and the registration distribution fraction within the given model year. The column labeled weighted miles per day was calculated as the product of the miles traveled per day and the registration distribution fraction. To obtain the composite 1999 base case LDGV NO_x emission factor, the sum of the weighted NO_x emission factors was divided by the sum of weighted miles per day. As shown in Table C-1, the 1999 base case LDGV NO_x emission factor under the conditions described above is 1.3075 grams per mile.

Figure C-1. 1999 Base Case MOBILE6.2 Input File

```
MOBILE6 INPUT FILE :

DAILY OUTPUT       :
DATABASE OUTPUT    :
WITH FIELDNAMES    :
DATABASE VEHICLES  : 21111 11111111 1 111 11111111 111
DATABASE FACILITIES: ARTERIAL none
POLLUTANTS         : NOX

RUN DATA           :
EXPRESS HC AS VOC  :
NO REFUELING       :
>SCENARIO: 1, AirControlNET BASE CASE
SCENARIO RECORD    : SUMMER 99 BASE
CALENDAR YEAR      : 1999
EVALUATION MONTH   : 7
AVERAGE SPEED      : 35 Arterial
MIN/MAX TEMP       : 70. 90.
FUEL RVP           : 8.7

END OF RUN         :
```

To follow Step 3, a second MOBILE6.2 input file was prepared. This input file is similar to that shown in Figure C-1. The only difference is that six scenarios were included, each modeling a different calendar year. The calendar years modeled were 2007, 2010, 2020, 2030, 2040, and 2050. The MOBILE6.2 output for each of these scenarios was processed in the same way as the base case file to obtain the total NO_x emission factors by model year for each of these calendar years. These emission factors are shown in Table C-2. The 2050 emission factors are the same as the 2040 emission factors by age, so they are not shown in this table. Model years from 2004 through 2008, shown in dark shading in Table C-2, represent the years that the Tier 2 standard is being phased in. Model years 2009 and later are shown in light shading in Table C-2. These are the model years where the Tier 2 standard has been completely phased in. Emission factors for the years that are not shaded on this table will not be used. To capture the low sulfur gasoline effects of the Tier 2 program on the model years not being replaced in 1999, a third MOBILE6.2 input file was developed. This input file simulated calendar year 1999 emission factors, using a 30 ppm sulfur gasoline. The input file is identical to that shown in Figure C-1, with the following additional command line added in the scenario section:

SULFUR CONTENT : 30.0

Table C-1. 1999 Base Case NO_x LDBF Emission Factors by Model Year

Model Year	Vehicle Age	LDGV NO_x Emission Factor (g/mi)	Miles Traveled per Day (miles)	Registration Distribution Fraction	Fuel Economy (mpg)	Weighted NO_x Emission Factor (grams)	Weighted Miles per Day (miles)
1975	24	7.213	12.2868	0.0102	16.8	0.904	0.1253
1976	23	7.7188	12.9232	0.0036	16.8	0.3591	0.0465
1977	22	8.5972	13.5945	0.0045	16.8	0.5259	0.0612
1978	21	8.0843	14.3001	0.0057	16.8	0.659	0.0815
1979	20	7.7857	15.0433	0.007	17.1	0.8199	0.1053
1980	19	6.1404	15.8235	0.0087	19.8	0.8453	0.1377
1981	18	2.898	16.6448	0.0106	21.2	0.5113	0.1764
1982	17	2.8338	17.5086	0.0137	22	0.6797	0.2399
1983	16	2.6799	18.4183	0.0177	21.9	0.8737	0.326
1984	15	2.6203	19.3732	0.0225	22.2	1.1422	0.4359
1985	14	2.5342	20.3781	0.0286	22.9	1.477	0.5828
1986	13	2.3167	21.4357	0.0363	23.7	1.8027	0.7781
1987	12	2.2502	22.5488	0.0459	23.8	2.3289	1.035
1988	11	1.8635	23.7195	0.0541	24.3	2.3913	1.2832
1989	10	1.7515	24.9498	0.059	23.9	2.5783	1.472
1990	9	1.64	26.2458	0.0629	23.9	2.7074	1.6509
1991	8	1.5373	27.6082	0.0657	23.9	2.7884	1.8139
1992	7	1.4175	29.0406	0.0678	23.9	2.791	1.969
1993	6	1.3131	30.5476	0.0692	23.9	2.7758	2.1139
1994	5	1.0542	32.1327	0.0701	23.9	2.3746	2.2525
1995	4	0.8123	33.8006	0.0705	23.9	1.9357	2.3829
1996	3	0.6353	35.5549	0.0707	23.9	1.597	2.5137
1997	2	0.5157	37.4003	0.0708	23.9	1.3655	2.6479
1998	1	0.4238	39.3409	0.0708	23.9	1.1804	2.7853
1999	0	0.3465	40.8534	0.0532	23.9	0.7531	2.1734
Total				**0.9998**		**38.167**	**29.1903**
Weighted NO_x Emission Factor (g/mi):						**1.3075**	

Emission factors resulting from this MOBILE6.2 run are also shown in Table C-2 in the column labeled 1999. The medium shading in this column indicates the model years affected in 1999 by the low sulfur gasoline. As shown in this table, only model years 1981 and newer are assumed to be affected by lower sulfur gasoline in MOBILE6.2.

Once the implementation year is selected in Step 4, Step 5 involves appropriately combining emission factors from Tables C-1 and C-2. This must be done so that the model years from the selected year of implementation subject to Tier 2 replace the emission factors of the vehicles of corresponding ages in Table C-1. For example, to simulate the Tier 2 2020 implementation schedule in 1999, start with the LDGV NO_x emission factors in Table C-1. Replace the emission factors for vehicles of age 16 and newer with the corresponding 2020 emission factors from Table C-2 for vehicles of the same age. These are the vehicles that would have been subject to Tier 2 emission standards in 2020 (e.g., model years 2004 and later). The remaining model years, aged 17 years and older, would be meeting the same emission standards that they would have met in the 1999 base case. However, vehicles aged 17 and 18 years, or from the 1981 and 1982 model years, would be affected by Tier 2 low sulfur gasoline in 1999. Thus, these emission factors receive the medium shading in Table C-3. Vehicles of age 12 through 16 represent the vehicles from model years 2004 through 2008 that represent phase-in Tier 2 emission standards. The vehicles 11 years and newer meet the full Tier 2 emission standards. Vehicles older than 18 years are not affected at all by the Tier 2 program in 1999. Thus, vehicles of 19 years of age and older receive their natural 1999 base case emission factors and are unaffected by the Tier 2 control.

Next, the emission factors shown in Table C-3 need to be combined with the daily VMT data and the registration distribution data shown in Table C-1. The same procedure applied to the emission factors in Table C-1 to obtain the weighted 1999 base case NO_x LDGV emission factor needs to be applied to the Table C-3 emission factors representing various degrees of Tier 2 implementation in 1999. As in Table C-1, each emission factor is first multiplied by the miles traveled per day and the registration distribution fraction shown in Table C-1 for vehicles of the same age. These products are summed for all 25 years of vehicles and divided by the sum of the 25 products of the miles traveled per day multiplied by the registration distribution fraction for each vehicle age. Table C-4 shows the resulting weighted emission factors for each of the years shown in Table C-3.

Under Step 6, the percent reduction from the 1999 base case NO_x emission factors to the weighted emission factors representing the various degrees of Tier 2 implementation in 1999 are calculated. These percent reductions are shown in Table C-4. The reductions shown for 1999 represent only the reductions that would be achieved by replacing conventional gasoline with 30 ppm sulfur gasoline with the current 1999 fleet of vehicles. By 2033, the full Tier 2 emission reduction potential would be reached, and all years thereafter would achieve the benefits shown in Table C-4 for 2040.

The final step involves applying the reduction percentages from Table C-4 to the 1999 base case AirControlNET emissions.

Table C-2. LDGV NO_x Emission Factors with Tier 2 in Various Calendar Years

	1999		2007		2010		2020		2030		
Vehicle Age	Model Year	Emission Factor (g/mi)	Model Year	Emission Factor (g/mi)	Model Year	Emission Factor (g/mi)	Model Year	Emission Factor (g/mi)	Model Year	Emission Factor (g/mi)	Model Year
24	1975	7.213	1983	3.147	1986	2.9167	1996	2.2013	2006	1.1842	2016
23	1976	7.7188	1984	3.072	1987	2.8789	1997	2.1313	2007	1.0726	2017
22	1977	8.5972	1985	2.9936	1988	2.5845	1998	2.0637	2008	0.9987	2018
21	1978	8.0843	1986	2.7241	1989	2.4847	1999	1.9922	2009	0.9096	2019
20	1979	7.7857	1987	2.6816	1990	2.4289	2000	1.9208	2010	0.8504	2020
19	1980	6.1404	1988	2.3707	1991	2.3583	2001	1.7965	2011	0.7933	2021
18	1981	2.7314	1989	2.2724	1992	2.2668	2002	1.6727	2012	0.7378	2022
17	1982	2.6717	1990	2.2089	1993	2.1963	2003	1.5323	2013	0.685	2023
16	1983	2.5209	1991	2.1342	1994	1.9116	2004	1.1158	2014	0.6327	2024
15	1984	2.4453	1992	2.0398	1995	1.6462	2005	0.8718	2015	0.582	2025
14	1985	2.3652	1993	1.9628	1996	1.4808	2006	0.5996	2016	0.5327	2026
13	1986	2.1613	1994	1.6805	1997	1.4071	2007	0.513	2017	0.4849	2027
12	1987	2.0997	1995	1.4197	1998	1.3359	2008	0.461	2018	0.4391	2028
11	1988	1.7414	1996	1.2546	1999	1.2573	2009	0.3938	2019	0.3938	2029
10	1989	1.6378	1997	1.1757	2000	1.1767	2010	0.3497	2020	0.3497	2030
9	1990	1.5345	1998	1.0957	2001	1.0491	2011	0.3067	2021	0.3067	2031
8	1991	1.4385	1999	1.0102	2002	0.9233	2012	0.2648	2022	0.2648	2032
7	1992	1.3271	2000	0.9233	2003	0.7851	2013	0.2242	2023	0.2242	2033
6	1993	1.2293	2001	0.7929	2004	0.4442	2014	0.1843	2024	0.1843	2034
5	1994	0.9584	2002	0.665	2005	0.2765	2015	0.1452	2025	0.1452	2035
4	1995	0.7084	2003	0.5313	2006	0.1425	2016	0.1097	2026	0.1097	2036
3	1996	0.5371	2004	0.2517	2007	0.0865	2017	0.0749	2027	0.0749	2037
2	1997	0.4335	2005	0.1184	2008	0.0496	2018	0.0408	2028	0.0408	2038
1	1998	0.3556	2006	0.0485	2009	0.0282	2019	0.0282	2029	0.0282	2039
0	1999	0.2907	2007	0.0293	2010	0.0224	2020	0.0224	2030	0.0224	2040

Table C-3. 1999 Base Year LDGV NO_x Emission Factors Under Various Tier 2 Implementation Years by Vehicle Age

Vehicle Age	Model Year	1999 Base Emission Factor (g/mi)	1999 with Tier 2 Emission Factor (g/mi)	2007 Emission Factor (g/mi)	2010 Emission Factor (g/mi)	2020 Emission Factor (g/mi)	2030 Emission Factor (g/mi)	2040 Emission Factor (g/mi)
24	1975	7.213	7.213	7.213	7.213	7.213	1.1842	1.0985
23	1976	7.7188	7.7188	7.7188	7.7188	7.7188	1.0726	1.0335
22	1977	8.5972	8.5972	8.5972	8.5972	8.5972	0.9987	0.9705
21	1978	8.0843	8.0843	8.0843	8.0843	8.0843	0.9096	0.9096
20	1979	7.7857	7.7857	7.7857	7.7857	7.7857	0.8504	0.8504
19	1980	6.1404	6.1404	6.1404	6.1404	6.1404	0.7933	0.7933
18	1981	2.898	2.7314	2.7314	2.7314	2.7314	0.7378	0.7378
17	1982	2.8338	2.6717	2.6717	2.6717	2.6717	0.685	0.685
16	1983	2.6799	2.5209	2.5209	2.5209	1.1158	0.6327	0.6327
15	1984	2.6203	2.4453	2.4453	2.4453	0.8718	0.582	0.582
14	1985	2.5342	2.3652	2.3652	2.3652	0.5996	0.5327	0.5327
13	1986	2.3167	2.1613	2.1613	2.1613	0.513	0.4849	0.4849
12	1987	2.2502	2.0997	2.0997	2.0997	0.461	0.4391	0.4391
11	1988	1.8635	1.7414	1.7414	1.7414	0.3938	0.3938	0.3938
10	1989	1.7515	1.6378	1.6378	1.6378	0.3497	0.3497	0.3497
9	1990	1.64	1.5345	1.5345	1.5345	0.3067	0.3067	0.3067
8	1991	1.5373	1.4385	1.4385	1.4385	0.2648	0.2648	0.2648
7	1992	1.4175	1.3271	1.3271	1.3271	0.2242	0.2242	0.2242
6	1993	1.3131	1.2293	1.2293	0.4442	0.1843	0.1843	0.1843
5	1994	1.0542	0.9584	0.9584	0.2765	0.1452	0.1452	0.1452
4	1995	0.8123	0.7084	0.7084	0.1425	0.1097	0.1097	0.1097
3	1996	0.6353	0.5371	0.2517	0.0865	0.0749	0.0749	0.0749
2	1997	0.5157	0.4335	0.1184	0.0496	0.0408	0.0408	0.0408
1	1998	0.4238	0.3556	0.0485	0.0282	0.0282	0.0282	0.0282
0	1999	0.3465	0.2907	0.0293	0.0224	0.0224	0.0224	0.0224

Table C-4. Weighted LDGV NO_x Emission Factors in 1999 with Varying Degrees of Tier 2 Implementation

Year of Tier 2 Implementation	Weighted 1999 LDGV NO_x Emission Factor (g/mi)	Percent Reduction from 1999 Base Case Emission Factor (%)
1999 Base Case	1.3075	
1999*	1.2101	7.4
2007	1.1082	15.2
2010	0.9296	28.9
2020	0.3787	71.0
2030	0.2151	83.5
2040	0.2146	83.6

*1999 represents only gasoline sulfur effects of Tier 2 program.

The example shown here illustrated only reductions obtained from NO_x for LDGVs. These same steps would be applied to all of the other pollutants included in AirControlNET. The only difference for other pollutants would be under Steps 2 and 3. In processing the MOBILE6.2 output file for NO_x, emission factors for two emission types were added together for each model year. In this case, the emission types were exhaust running emissions and exhaust engine start emissions. These same two components would be processed for CO, SO_2, and NH_3. However, the processing of the VOC output must also include the evaporative emission types: hot soak, diurnal, resting loss, running loss, and crankcase emission factors. Both the PM_{10} and $PM_{2.5}$ processing must also include the brake wear and tire wear emission types in addition to the exhaust emission types. The procedures would not change for any of the other vehicle types. However, diesel vehicles do not have any evaporative emission components and heavy duty vehicles do not include a separate exhaust engine start component.

An advantage to this procedure is the ease with which it can be adapted to additional base years, beyond 1999. For a different base year, Step 2 would need to be recalculated using a different base year MOBILE6.2 input file. However, the emission factors calculated for the projection years, as shown in Table C-2, would not need to be changed. The combination of emission factors from the base year and projection years would need to change. For example, if 2010 were the new base year, and a 2020 year of Tier 2 implementation in 2010 were desired, the Table C-2 emission factors for 2010 from vehicles of age 17 and older would be combined with the 2020 emission factors for vehicles of age 16 and newer.

The steps laid out in this example are applicable for any control measure that could be modeled in MOBILE6.2. This includes both fuel and emission standard control measures, as well as vehicle inspection programs. In addition, the model year-specific emission factors obtained from MOBILE6.2 can be adjusted to account for other control measures that cannot be explicitly modeled in MOBILE6.2. This would include measures like retrofitting HDDVs with particulate traps, replacing a portion of the fleet with hybrid or electric vehicles, or scrapping a portion of the older model year vehicles or trucks. Control measures that involve changes in activity (VMT) to specific vehicle types, but that are not specific to model year, would be modeled in AirControlNET by reducing emissions in direct proportion to the reduction in VMT. However, if an activity-based control measure is more specific to particular model years of vehicles, the emission factors would first be adjusted for the necessary model years.

Tier 2

Representative scenario conditions were chosen based on their influence on emissions with Tier2 control measures in place. The conditions that were determined to significantly influence Tier2 emissions as a result of this sensitivity testing are temperature, speed, and presence or absence of enhanced inspection/maintenance (I/M) and anti-tampering programs. Input files were prepared that modeled the base case and Tier 2 effects under each of these conditions, both with and without low sulfur gasoline fuel. Emission factors were combined by model year and vehicle type such that the appropriate model years and vehicle types received the appropriate control measures. Specifically, the Tier 2 engine and vehicle control measure is applicable to all light duty vehicles beginning with the 2004 model year; the Tier 2 low sulfur gasoline control measure is applicable to all gasoline vehicles beginning with the 1981 model year. Heavy duty diesel vehicles and motorcycles are not affected by this control.

A percent difference was calculated based on the difference in the weighted average emission factor between the control and base cases for each vehicle type. In this case, because there were multiple control cases (temperature and speed), the percent reductions were combined in order to get a single control efficiency for each vehicle type in each model year for counties with and without I/M programs. The percent reductions from the various temperature runs (summer and winter) were combined by weighting the two values equally (for base speed, low speed and high speed). Then, the adjusted percent reductions for each speed were combined in the following way to get a single percent reduction for those with and without I/M programs: 50.46% for base speed, 39.87% for low speed, and 9.67% for high speed, based on the fraction of VMT expected to occur under these conditions in the 1999 base emissions. These percent reductions were then applied directly to the 1999 base case emissions based on whether or not an I/M program was active in that county. Please note that there is a separate percent reduction for each vehicle type, model year (2010, 2015, 2020, 2030), pollutant, and I/M status.

The costs of the Tier 2 program were summarized as per vehicle and per gallon costs from the Regulatory Impact Analysis prepared by the EPA (EPA, 1999). In order to summarize these costs, the degree of implementation among each vehicle type was determined. An estimate of the number of vehicles affected by the control was calculated by dividing the VMT by the average annual mileage accumulation rate for each affected vehicle type and model year. This fraction of vehicles was then applied to the number of vehicles reported in the 1999 base case data, and multiplied by the cost per vehicle. The cost per vehicle was summarized from the cost reported in the EPA report to the vehicle type level that is reported in AirControlNET. This was done by weighting each vehicle type by the relevant VMT fraction, and then summing to a new vehicle type summary level. These per vehicle and per gallon costs were then applied to all relevant vehicle types for each model year. The cost per ton was estimated by identifying the major pollutant controlled by this measure as NO_x and dividing the cost of the measure by the tons of NO_x emissions controlled.

Heavy Duty Diesel

In the case of the heavy duty diesel control measure, Pechan made the assumption that varying the modeling conditions would have little effect on the emissions reductions achieved by this measure. In other words, other factors such as temperature, speed and the presence or absence of enhanced I/M and ATP programs were not taken into account. Therefore, input files that represented the base case and diesel control measures were prepared, including those with and without low sulfur diesel fuel. Emission factors were combined by model year and vehicle type such that the appropriate model years and vehicle types received the appropriate control measures. The heavy duty diesel engine and vehicle control measures are applicable to all heavy duty diesel vehicles beginning with the 2007 model year, and all heavy duty gasoline vehicles beginning with the 2008 model year. Light duty diesel vehicles also felt the effects of the low sulfur diesel fuel standard. Light duty gasoline vehicles and motorcycles are not affected by this control.

A percent difference was calculated based on the difference in the weighted average emission factor between the control and base cases for each vehicle type. These percent reductions were then applied directly to the 1999 base case emissions. Please note that there is a separate percent reduction for each vehicle type, model year (2010, 2015, 2020, 2030), and pollutant. This modeling effort is simpler than the Tier 2 scenario because there are fewer conditions that have to be taken into account as having an effect on the emissions reductions received by the control measure.

The costs of the heavy duty diesel program were summarized as per vehicle and per gallon costs from the Regulatory Impact Analysis prepared by the EPA (EPA, 2000). In order to summarize these costs, the degree of implementation among each vehicle type was determined. An estimate of the number of vehicles affected by the control was calculated by dividing the VMT by the average annual mileage accumulation rate for each affected vehicle type and model year. This fraction of vehicles was then applied to the number of vehicles reported in the 1999 base case data, and multiplied by the cost per vehicle. The cost per vehicle was summarized from the cost reported in the EPA report to the vehicle type level that is reported in AirControlNET. This was done by weighting each vehicle type by the relevant VMT fraction, and then summing to a new vehicle type summary level. These per vehicle and per gallon costs were then applied to all relevant vehicle types for each model year. The cost per ton was estimated by identifying the major pollutant controlled by this measure as NO_x and dividing the cost of the measure by the tons of NO_x emissions controlled.

Voluntary Diesel Retrofit

The voluntary diesel retrofit program was approached differently than the other two control measures. The main reason for this is that the emission factors cannot be modeled using MOBILE6.2, as the conditions in the model do not allow for this control. Therefore, Pechan conducted extensive research on the various retrofit techniques available to those interested in participating in the program. Control efficiencies and costs were collected for a variety of controls. In the end, Pechan chose four retrofit controls to estimate the costs of benefits of for this program: 1) diesel particulate filter; 2) diesel oxidation catalyst; 3) selective catalytic reduction; and 4) biodiesel fuel. These four controls represent the variety of retrofit controls in terms of type, function, and cost. More detailed information on the methodology of including the retrofit controls in this analysis can be found in the Pechan memo prepared for US EPA's Tyler Fox in July 2003 (Pechan, 2003).

The range of control efficiencies researched for each retrofit technology was averaged, and a single percent reduction was applied to the 1999 base emissions for each vehicle type. Due to the fact that there are four controls for this measure, multiple years were not modeled here. A similar methodology was employed for the costs: the range of researched costs was averaged and applied to all relevant vehicles (i.e., all heavy duty diesel vehicles). Please note that the first three retrofit technologies require the use of low sulfur diesel fuel, so the percent reductions and costs of this fuel are included in these analyses. In order to determine the percent reductions achieved from the fuel alone, MOBILE6.2 input files were prepared with base high sulfur diesel fuel and base low sulfur diesel fuel. The percent reductions were calculated and this control efficiency was incorporated into the control efficiency for the retrofit technology alone to achieve a combined control efficiency.

REFERENCES

EPA, 1999: U.S. Environmental Protection Agency, “Regulatory Impact Analysis - Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements,” EPA420-R-99-023, December 1999.

EPA, 2000: U.S. Environmental Protection Agency, “Regulatory Impact Analysis: Control of Emissions of Air Pollution from Highway Heavy-Duty Engines,” EPA420-R-00-010, July 2000.

Pechan, 2003: E.H. Pechan & Associates, “Methodology to Implement Voluntary Diesel Retrofit Program in AirControlNET,” memo prepared for Tyler Fox of the U.S. Environmental Protection Agency, July 2003.

APPENDIX D: NONROAD MOBILE CONTROL MEASURES

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INTRODUCTION

The focus of AirControlNET has primarily been to evaluate control measures for stationary sources (i.e., EGUs, nonEGUs, and area sources) and estimate emissions reduction and the associated costs. However, in order to gain a more complete picture of available control measures for policy consideration and for conducting "what if" scenarios we found it necessary to include control measures available for onroad and nonroad mobile sources. Thus, the purpose of this appendix is to document the development and implementation of a capability within AirControlNET to evaluate nonroad source control measures, i.e., estimate emission reductions and costs from a baseline emissions inventory. For nonroad sources, we conducted model simulations of EPA's NONROAD model to develop control measure data for inclusion into AirControlNET (provide cite for this model). This initial effort focused on including such data associated with the implementation of the following engine standards for the years 2010, 2015, 2020, and 2030:

1) Tier 1, Tier 2, and Tier 3 emission standards for nonroad C-I engines at or above 50 hp, not including recreational marine (63 FR 56968, 1998).

2) Final emission standards for nonroad large S-I engines and land-based recreational engines (67 FR 68242, 2002).

For each of these standards, a database of year-specific control efficiencies and costs per engine by category (i.e., 7- or 10-digit SCC) was developed for application to a 1999 base year inventory (i.e., NEI v2.0). This appendix provides the steps taken to estimate the emission reductions, applicability, and costs associated with each of the above control programs for inclusion into AirControlNET.

In order to develop additional mobile source inputs using the methods described below, the NONROAD model would need to be run to estimate the emissions reductions. EPA is currently developing the National Mobile Inventory Model (NMIM) which is a consolidated emissions modeling system for mobile and nonroad emissions inventory development. It is expected that at some time in the future, NMIM will replace these models. However, as currently configured, AirControlNET is not connected to NMIM..

Table D-1 shows a summary of the federal emission standards affecting NONROAD model category engines as well as the corresponding source classification codes (SCCs), engine size or horsepower (hp), and pollutants. As shown, the NONROAD model category controls include the following spark-ignition (S-I) (i.e., gasoline) and compression-ignition (C-I) (i.e., diesel) engine emission standards:

- Phase I and Phase II emission standards for new nonroad S-I engines at or below 25 horsepower (hp). Promulgated July 1995 (Phase I), March 30, 1999 (Phase II Non-handheld), and April 2000 (Phase II Handheld).

- Emission standards for new gasoline S-I marine engines (61 FR 52088, 1996).

- Tier 1 and Tier 2 emission standards for nonroad C-I engines below 50 hp, including recreational marine (61 FR 58101, 1996).

- Tier 1, Tier 2, and Tier 3 emission standards for nonroad C-I engines at or above 50 hp, not including recreational marine (63 FR 56968, 1998).

Additional final and proposed controls not reflected in EPA's NONROAD model include:

- Final emission standards for nonroad large S-I engines, and marine and land-based recreational engines (67 FR 68242, 2002).

- Proposed emission standards for evaporative emissions from gasoline-fueled recreational boats (67 FR 53050, 2002).

- Proposed Tier 4 emission standards and low sulfur diesel fuel requirements (68 FR 28328, 2003).

Future efforts are expected to incorporate those federal programs not accounted for in the current version of AirControlNET as well as other control options that are technically feasible to achieve criteria air pollutant reductions from nonroad sources now and in the future.

EMISSION REDUCTIONS

Pechan ran the NONROAD2002b version of the model at the national level for 1999, 2010, 2015, 2020, and 2030. Pechan used model default values for temperature, and Reid vapor pressure (RVP). For the diesel fuel sulfur, EPA's Office of Transportation and Air Quality (OTAQ) recommended using a default national average diesel fuel sulfur content of 2,318 parts per million (ppm) for 1999, and a value of 2,217 ppm for all future year runs. Revised model input files to reflect the above-mentioned large S-I and recreational standards were also provided by OTAQ, since the NONROAD2002b version does not include the effects of these standards.

NONROAD outputs emissions and accounts for changes in the distribution of engine technology types as new, cleaner engines are phased in. We estimated emission reductions (i.e., control efficiencies) associated with a specific standard and year of implementation in 1999 by comparing changes in pollutant emissions between a base year of 1999 and each future year, while holding growth in equipment populations constant (i.e., growth factor of 1). This was accomplished by revising the growth input file (nation.grw) to reflect a constant level of growth.

In the case of SCCs affected by the large S-I standards, there may be overlap between the large S-I and small S-I standards, if an SCC includes engines that are both above and below 25 horsepower. To determine the actual reduction associated with only the large S-I standards, we adjusted the technology file to remove all technology fractions associated with the small S-I standards. In this manner, a control factor is calculated that already accounts for the rule penetration that should be applied to SCC-level emissions, given that emissions for all engines within the SCC may not be subject to the large S-I standard. Because the C-I standards and recreational gasoline standards apply to all horsepower ranges within an SCC, this adjustment was not needed for standards other than large S-I.

Tables D-2a through D-2d present the year-specific control efficiencies by equipment category (i.e., 7-digit SCC) or by equipment application (10-digit SCC). These values were calculated by taking the difference between the pollutant emissions for 2010 (or alternate implementation year) and pollutant emissions for 1999, dividing by pollutant emissions for 1999, and multiplying by 100. Pechan estimated emission reductions for a given year at the equipment category, or 7-digit SCC level, for most categories, with some exceptions. Therefore, most base year SCC emissions for NONROAD model engines will be aggregated to the 7 digit SCC-level of detail (i.e., with 7-digit specificity, followed by three zeroes). This approach simplifies calculations without losing needed resolution and decreases the storage needed to house a county-level nonroad inventory for the nation, which typically comprises over 200 SCCs.

NUMBER OF AFFECTED ENGINES

This section discusses how Pechan estimated the number of affected engines by technology type (i.e., by Phase or Tier) for each implementation year, using results from the NONROAD runs described in Section II, and scrappage rate data from the model. Since we are modeling future year reductions in 1999, we do not want to reflect growth in engines, and therefore set the growth to 1. The output data used from the model are equipment populations by SCC and technology type. These steps are described by presenting an example of these calculations for commercial C-I engines less than 50 hp for the year 2010, relative to 1999.

Table D-3 presents the total number of commercial sector C-I engines of less than 50 hp in each tier category for years 1999 and 2010. Because the effect of growth has been removed, the number of engines turned over to a higher Tier category can be obtained from these results. The total number of engines is the same for 1999 and 2010 (449,154), but the distribution of engines among tiers differs and indicates the number of engines that have turned over to that Tier, with the exception of Tier 1 engines. Since Tier 1 engines are present in the 1999 base year, an adjustment is needed, as described below.

The table shows a count of 178,062 engines affected by Tier 2. This estimate represents engines that are turned over from Base emission levels to Tier 2 levels and engines that are turned over from Tier 1 levels to Tier 2 levels. (To simplify the calculations, we estimated control costs for all Tier 2 engines by multiplying the total number of Tier 2 engines that have been turned over from higher-emitting levels by the incremental cost of achieving Tier 2 emission standards from Base emission levels.) There are also 165,530 engines emitting at Base levels in 2010 from the 442,464 engines emitting at that level in 1999.

Since Tier 1 engines are present in the 1999 base year, it is necessary to calculate the number of Tier 1 engines that are still operating in 2010. This step is accomplished by multiplying the 1999 count of engines (6,690) by one minus the scrappage rate (1 - 0.849). The resulting engine count (1,010) is then subtracted from the number of Tier 1 engines in 2010 (105,563). These steps leave an estimate of 104,552 engines that have turned over from Base emission levels to Tier 1 levels by 2010. To represent the 2010 year implementation of the C-I engine standards, the per engine costs associated with each Tier level are multiplied by the number of engines that have turned over to each standard between 1999 and 2010, which is 178,062 Tier 2 engines and 104,552 Tier 1 engines.

Table D-4 presents the C-I scrappage rates by equipment category, hp range and implementation year for adjusting the number of Tier 1 C-I engines. The scrappage rates were derived by first calculating the average annual hours of use, the average load factor, and the average median life for each equipment category, based on the NONROAD model data for these variables. For a given implementation year, the average annual hours of use was multiplied by the number of years between the base year 1999 and the future year of interest to calculate the percent of median life used. These values were then correlated to the default scrappage curve shown in Table D-5, also obtained from the NONROAD model (EPA, 2002a). For large S-I engines and recreational equipment, the number of engines can be obtained directly from the model results, since there are no standard-based technology types in the base year (i.e., none of the standards come into affect by 1999).

COSTS PER ENGINE

This section discusses the per engine costs applied to the number of affected engines. All costs represent the production and compliance costs for an engine to meet the standard, and do not include costs associated with fuel savings. As mentioned in Section III, all costs applied are incremental to the base case. For example, Tier 2 costs that are incremental to Tier 1 costs are added to the reported Tier 1 costs to estimate the cost involved in converting an engine from Base level to Tier 2.

Table D-6 provides the combined engine and equipment costs from the Regulatory Impact Analysis (RIA) for the Federal Tier 1, 2, and 3 nonroad diesel standards (EPA, 1998). Costs represent first-year costs, and differ by engine horsepower ranges. Long-term costs are also available, but first-year, or near-term costs will be used for modeling future reductions occurring in a base year of 1999. EPA developed a cost estimate for a single engine near the middle of the ranges presented, so these are approximations, and the costs will be higher for engines on the high end of the power range, and vice versa.

Tier 1 costs for engines greater than 50 hp are presented in the Regulatory Support Document (RSD) for the 1994 rulemaking (EPA, 1994). These annualized costs are presented in Table 3-07 of the RSD on a present value per engine basis, expressed in 1992 dollars. Unlike the costs for the 1998 rulemaking, which are presented by hp range, per engine costs are based on a weighted average variable cost methodology, and are not broken out by hp range. Therefore the costs to comply with Tier 1 standards for all engines greater than 50 hp are assumed to be the same ($229) for all sized engines.

Tables D-7 and D-8 provide the near-term incremental engine costs obtained from the final RSD for the Large S-I and Recreational Equipment Standards (EPA, 2002b). First year costs for meeting Phase 1 (2004) and Phase 2 (2007) standards for large gasoline and compressed natural gas (CNG)/liquefied petroleum gasoline (LPG) S-I engines were obtained from Table 5.2.2-6 of the RSD. Since CNG and LPG engines use comparable technologies, a single set of costs is presented for application to both fuels. In addition, costs associated with permeation control are subtracted from the costs per engine since NONROAD does not model the effect of the large S-I gasoline evaporative standards in reducing future year evaporative hydrocarbon emissions. Note that a limitation of the costs for large S-I engines for application to SCC-level emissions in the inventory is that costs for large 2-stroke engines to meet the standards are not available. The near term cost will, therefore, underestimate costs for 2-stroke engines, since it does not account for the cost of 4-stroke conversion. However, the population of large 2-stroke gasoline engines is considerably less compared to the population of large 4-stroke engines.

First year costs for meeting Phase 1 (2006) standards for all-terrain vehicle (ATV) and off-highway motorcycle engines were obtained from Table 5.2.2-23 and 5.2.2-24 of the RSD, respectively. Costs for 2-stroke to 4-stroke conversion were available for the recreational vehicle categories, so these costs will be applied to 2-stroke engine SCCs. Costs for this engine conversion, as well as pulse air/recalibration technology, are weighted by sales within a displacement class. Also, costs associated with permeation control are subtracted from the costs per engine since NONROAD does not model the effect of the recreational gasoline evaporative standards.

Unlike other technology types included in the NONROAD model that typically represent a mix of several technologies to meet a specified Tier or Phase standards, the technology types for snowmobiles represent distinct technologies (Carlson, 2003). These same technologies are used by the affected engines in varying proportions to meet each of the three Phases of the rule (Phase 1 in 2006, Phase 2 in 2010, and Phase 3 in 2012). First year costs for meeting the Phase 1 through Phase 3 standards for snowmobile engines were obtained from data in Tables 5.2.2-20 through 5.2.2-22. Table D-8 shows costs weighted by sales within a displacement class, and describes the basis of the costs. In addition, costs associated with permeation control are subtracted from the costs per engine since NONROAD does not model the effect of snowmobile evaporative standards.

For the final step, costs per county associated with the emission reductions were estimated. Since the NONROAD model runs were done on a national basis, the number of affected engines were available at the national level only. Per engine costs were applied to the number of engines to estimate total costs by equipment category. These costs were then allocated to the county level based on the total number of engines per county, developed previously for the 1999 NEI, Version 2.0.

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Table D-1. Summary of NONROAD Model Category Control Programs

SCC	Description	Standard	Applicable HP	Pollutants
Specific applications of 2260*	Gasoline Class III, IV, and V engines[1]	Phase I/II Small Spark-Ignition Handheld Engines	<25 hp	HC, NO_x
Specific applications of 2265*	Gasoline Class I and II engines[1]	Phase I/II Small Spark-Ignition Non-handheld Engines	<25 hp	HC, NO_x
2260xxxxxx 2265xxxxxx 2267xxxxxx 2268xxxxxx	2-stroke gasoline 4-stroke gasoline Liquefied petroleum gasoline (LPG) Compressed natural gasoline (CNG)	Tier 1/Tier 2 Large Spark-Ignition	>=25 hp	HC, NO_x, CO
2260001010	Gasoline Off-highway Motorcycles	Recreational Vehicles	All hp	HC, NO_x, CO
2260001020	Gasoline Snowmobiles	Recreational Vehicles	All hp	HC, CO
2260001030	Gasoline ATVs	Recreational Vehicles	All hp	HC, NO_x, CO
2282005xxx 2282010xxx	Gasoline Pleasure Craft - Outboard, Personal Watercraft, and Inboard	Recreational Marine Exhaust Emission Standards	All hp	Exhaust HC
2282005xxx 2282010xxx	Gasoline Pleasure Craft - Outboard, Personal Watercraft, and Inboard	Evaporative Emission Standards (Proposed)	All hp	Evaporative HC
2270xxxxxx	Diesel Equipment Diesel Pleasure Craft	Tier ½/3 Compression-Ignition Tier ½ Compression-Ignition	All hp <50 hp	HC, NO_x, PM
2282020xxx	Diesel Pleasure Craft	Diesel Recreational Marine	>50 hp	HC, NO_x, CO, PM

[1]EPA established technology classes based on use (hand-held versus non-handheld and displacement) that are predominantly 2-stroke (Class III, IV, and V), or 4-stroke (Class I and II) engines.

Table D-2a. Control Factors by Nonroad Equipment Category for 2010

SCC	Description	Federal Measure	Control Factor (%) [1]				
			VOC	PM_{10}	$PM_{2.5}$	CO	NO_x
2260001010	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Motorcycles: Off-road	Motorcycle	20%	20%	20%	9%	-27%
2260001020	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Snowmobiles	Snowmobile	20%	10%	10%	17%	-66%
2260001030	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; All Terrain Vehicles;	ATVs	34%	34%	34%	6%	-27%
2260001060	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	13%	0%	0%	4%	-23%
2260006000	Off-highway Vehicle Gasoline, 2-Stroke; Commercial Equipment	Large S-I	1%	0%	0%	1%	-1%
2265001010	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; Motorcycles: Off-road	Motorcycle	5%	0%	0%	14%	7%
2265001030	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; All Terrain Vehicles;	ATVs	14%	0%	0%	5%	16%
2265001060	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	17%	7%	7%	6%	-26%
2265002000	Off-highway Vehicle Gasoline, 4-Stroke; Construction and Mining Equipment	Large S-I	9%	5%	5%	5%	17%
2265004000	Off-highway Vehicle Gasoline, 4-Stroke; Lawn and Garden Equipment	Large S-I	10%	6%	6%	1%	1%
2265005000	Off-highway Vehicle Gasoline, 4-Stroke; Agricultural Equipment	Large S-I	19%	1%	1%	12%	28%
2265006000	Off-highway Vehicle Gasoline, 4-Stroke; Commercial Equipment	Large S-I	5%	-4%	-4%	3%	-2%
2265008000	Off-highway Vehicle Gasoline, 4-Stroke; Airport Ground Support Equipment	Large S-I	30%	0%	0%	31%	59%
2267001060	Off-highway LPG; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	21%	0%	0%	14%	23%
2267002000	Off-highway LPG; Construction and Mining Equipment	Large S-I	58%	0%	0%	44%	61%
2267003000	Off-highway LPG; Industrial Equipment	Large S-I	69%	6%	6%	52%	73%
2267004000	Off-highway LPG; Lawn and Garden Equipment	Large S-I	72%	0%	0%	54%	76%
2267005000	Off-highway LPG; Agricultural Equipment	Large S-I	51%	0%	0%	38%	55%
2267006000	Off-highway LPG; Commercial Equipment	Large S-I	42%	0%	0%	28%	44%
2267008000	Off-highway LPG; Airport Ground Support Equipment	Large S-I	73%	0%	0%	54%	77%
2268002000	Off-highway CNG; Construction and Mining Equipment	Large S-I	34%	0%	0%	23%	37%
2268005000	Off-highway CNG; Agricultural Equipment	Large S-I	54%	0%	0%	36%	60%
2268006000	Off-highway CNG; Commercial Equipment	Large S-I	78%	0%	0%	75%	73%
2270001000	Off-highway Vehicle Diesel; Recreational Equipment	C-I	26%	22%	22%	23%	14%
2270002000	Off-highway Vehicle Diesel; Construction and Mining Equipment	C-I	53%	42%	42%	47%	41%
2270003000	Off-highway Vehicle Diesel; Industrial Equipment	C-I	60%	42%	42%	37%	40%
2270004000	Off-highway Vehicle Diesel; Lawn and Garden Equipment	C-I	60%	48%	48%	46%	33%
2270005000	Off-highway Vehicle Diesel; Agricultural Equipment	C-I	56%	50%	50%	49%	36%
2270006000	Off-highway Vehicle Diesel; Commercial Equipment	C-I	42%	33%	33%	33%	23%
2270007000	Off-highway Vehicle Diesel; Logging Equipment	C-I	55%	40%	40%	53%	49%
2270008000	Off-highway Vehicle Diesel; Airport Ground Support Equipment	C-I	59%	50%	50%	52%	46%
2285002015	Railroad Equipment; Diesel; Railway Maintenance	C-I	40%	41%	41%	40%	30%
2285004015	Railroad Equipment; Gasoline, 4-Stroke; Railway Maintenance	Large S-I	4%	0%	0%	2%	0%
2285006015	Railroad Equipment; LPG; Railway Maintenance	Large S-I	43%	0%	0%	30%	47%

[1] The control factor incorporates values for both control efficiency and rule penetration.

Table D-2b. Control Factors by Nonroad Equipment Category for 2015

SCC	Description	Federal Measure	Control Factor (%) [1]				
			VOC	PM_{10}	$PM_{2.5}$	CO	NO_x
2260001010	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Motorcycles: Off-road	Motorcycle	40%	41%	41%	18%	-54%
2260001020	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Snowmobiles	Snowmobile	45%	31%	31%	38%	-180%
2260001030	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; All Terrain Vehicles;	ATVs	73%	73%	73%	14%	-57%
2260001060	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	14%	0%	0%	4%	-23%
2260006000	Off-highway Vehicle Gasoline, 2-Stroke; Commercial Equipment	Large S-I	1%	0%	0%	1%	0%
2265001010	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; Motorcycles: Off-road	Motorcycle	10%	0%	0%	29%	14%
2265001030	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; All Terrain Vehicles;	ATVs	27%	0%	0%	9%	30%
2265001060	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	22%	7%	7%	8%	-32%
2265002000	Off-highway Vehicle Gasoline, 4-Stroke; Construction and Mining Equipment	Large S-I	10%	5%	5%	6%	24%
2265004000	Off-highway Vehicle Gasoline, 4-Stroke; Lawn and Garden Equipment	Large S-I	10%	6%	6%	1%	2%
2265005000	Off-highway Vehicle Gasoline, 4-Stroke; Agricultural Equipment	Large S-I	24%	0%	0%	16%	38%
2265006000	Off-highway Vehicle Gasoline, 4-Stroke; Commercial Equipment	Large S-I	6%	-4%	-4%	4%	1%
2265008000	Off-highway Vehicle Gasoline, 4-Stroke; Airport Ground Support Equipment	Large S-I	40%	0%	0%	43%	77%
2267001060	Off-highway LPG; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	38%	0%	0%	31%	41%
2267002000	Off-highway LPG; Construction and Mining Equipment	Large S-I	81%	0%	0%	73%	81%
2267003000	Off-highway LPG; Industrial Equipment	Large S-I	92%	6%	6%	86%	91%
2267004000	Off-highway LPG; Lawn and Garden Equipment	Large S-I	92%	0%	0%	86%	91%
2267005000	Off-highway LPG; Agricultural Equipment	Large S-I	74%	0%	0%	66%	75%
2267006000	Off-highway LPG; Commercial Equipment	Large S-I	67%	0%	0%	55%	67%
2267008000	Off-highway LPG; Airport Ground Support Equipment	Large S-I	93%	0%	0%	87%	91%
2268002000	Off-highway CNG; Construction and Mining Equipment	Large S-I	60%	0%	0%	49%	63%
2268005000	Off-highway CNG; Agricultural Equipment	Large S-I	88%	0%	0%	80%	88%
2268006000	Off-highway CNG; Commercial Equipment	Large S-I	83%	0%	0%	79%	79%
2270001000	Off-highway Vehicle Diesel; Recreational Equipment	C-I	38%	33%	33%	34%	21%
2270002000	Off-highway Vehicle Diesel; Construction and Mining Equipment	C-I	65%	46%	46%	52%	53%
2270003000	Off-highway Vehicle Diesel; Industrial Equipment	C-I	70%	40%	40%	37%	50%
2270004000	Off-highway Vehicle Diesel; Lawn and Garden Equipment	C-I	71%	55%	55%	52%	41%
2270005000	Off-highway Vehicle Diesel; Agricultural Equipment	C-I	68%	59%	59%	57%	48%
2270006000	Off-highway Vehicle Diesel; Commercial Equipment	C-I	57%	44%	44%	43%	33%
2270007000	Off-highway Vehicle Diesel; Logging Equipment	C-I	64%	37%	37%	53%	59%
2270008000	Off-highway Vehicle Diesel; Airport Ground Support Equipment	C-I	69%	52%	52%	56%	59%
2285002015	Railroad Equipment; Diesel; Railway Maintenance	C-I	54%	50%	50%	52%	43%
2285004015	Railroad Equipment; Gasoline, 4-Stroke; Railway Maintenance	Large S-I	5%	0%	0%	2%	3%
2285006015	Railroad Equipment; LPG; Railway Maintenance	Large S-I	74%	0%	0%	62%	77%

[1] The control factor incorporates values for both control efficiency and rule penetration.

Table D-2c. Control Factors by Nonroad Equipment Category for 2020

SCC	Description	Federal Measure	Control Factor (%) [1]				
			VOC	PM_{10}	$PM_{2.5}$	CO	NO_x
2260001010	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Motorcycles: Off-road	Motorcycle	50%	51%	51%	22%	-66%
2260001020	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Snowmobiles	Snowmobile	62%	49%	49%	51%	-264%
2260001030	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; All Terrain Vehicles;	ATVs	95%	95%	95%	19%	-72%
2260001060	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	14%	0%	0%	4%	-23%
2260006000	Off-highway Vehicle Gasoline, 2-Stroke; Commercial Equipment	Large S-I	1%	0%	0%	1%	0%
2265001010	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; Motorcycles: Off-road	Motorcycle	12%	0%	0%	36%	17%
2265001030	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; All Terrain Vehicles;	ATVs	33%	0%	0%	11%	36%
2265001060	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	25%	6%	6%	10%	-31%
2265002000	Off-highway Vehicle Gasoline, 4-Stroke; Construction and Mining Equipment	Large S-I	11%	5%	5%	7%	27%
2265004000	Off-highway Vehicle Gasoline, 4-Stroke; Lawn and Garden Equipment	Large S-I	10%	6%	6%	1%	2%
2265005000	Off-highway Vehicle Gasoline, 4-Stroke; Agricultural Equipment	Large S-I	28%	-2%	-2%	19%	44%
2265006000	Off-highway Vehicle Gasoline, 4-Stroke; Commercial Equipment	Large S-I	6%	-4%	-4%	4%	3%
2265008000	Off-highway Vehicle Gasoline, 4-Stroke; Airport Ground Support Equipment	Large S-I	42%	0%	0%	46%	81%
2267001060	Off-highway LPG; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	55%	0%	0%	47%	58%
2267002000	Off-highway LPG; Construction and Mining Equipment	Large S-I	90%	0%	0%	84%	89%
2267003000	Off-highway LPG; Industrial Equipment	Large S-I	95%	6%	6%	90%	93%
2267004000	Off-highway LPG; Lawn and Garden Equipment	Large S-I	95%	0%	0%	90%	92%
2267005000	Off-highway LPG; Agricultural Equipment	Large S-I	83%	0%	0%	77%	82%
2267006000	Off-highway LPG; Commercial Equipment	Large S-I	80%	0%	0%	70%	79%
2267008000	Off-highway LPG; Airport Ground Support Equipment	Large S-I	95%	0%	0%	90%	92%
2268002000	Off-highway CNG; Construction and Mining Equipment	Large S-I	82%	0%	0%	73%	83%
2268005000	Off-highway CNG; Agricultural Equipment	Large S-I	93%	0%	0%	90%	92%
2268006000	Off-highway CNG; Commercial Equipment	Large S-I	87%	0%	0%	82%	84%
2270001000	Off-highway Vehicle Diesel; Recreational Equipment	C-I	49%	43%	43%	44%	28%
2270002000	Off-highway Vehicle Diesel; Construction and Mining Equipment	C-I	70%	48%	48%	54%	57%
2270003000	Off-highway Vehicle Diesel; Industrial Equipment	C-I	72%	40%	40%	37%	52%
2270004000	Off-highway Vehicle Diesel; Lawn and Garden Equipment	C-I	75%	58%	58%	55%	45%
2270005000	Off-highway Vehicle Diesel; Agricultural Equipment	C-I	75%	63%	63%	61%	56%
2270006000	Off-highway Vehicle Diesel; Commercial Equipment	C-I	67%	50%	50%	49%	41%
2270007000	Off-highway Vehicle Diesel; Logging Equipment	C-I	65%	37%	37%	53%	61%
2270008000	Off-highway Vehicle Diesel; Airport Ground Support Equipment	C-I	72%	51%	51%	57%	64%
2285002015	Railroad Equipment; Diesel; Railway Maintenance	C-I	65%	57%	57%	61%	53%
2285004015	Railroad Equipment; Gasoline, 4-Stroke; Railway Maintenance	Large S-I	5%	0%	0%	3%	4%
2285006015	Railroad Equipment; LPG; Railway Maintenance	Large S-I	89%	0%	0%	84%	88%

[1] The control factor incorporates values for both control efficiency and rule penetration.

Table D-2d. Control Factors by Nonroad Equipment Category for 2030

SCC	Description	Federal Measure	Control Factor (%) [1] VOC	PM_{10}	$PM_{2.5}$	CO	NO_x
2260001010	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Motorcycles: Off-road	Motorcycle	52%	52%	52%	23%	-68%
2260001020	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Snowmobiles	Snowmobile	69%	58%	58%	56%	-305%
2260001030	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; All Terrain Vehicles;	ATVs	97%	97%	97%	20%	-73%
2260001060	Off-highway Vehicle Gasoline, 2-Stroke; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	16%	0%	0%	4%	-23%
2260006000	Off-highway Vehicle Gasoline, 2-Stroke; Commercial Equipment	Large S-I	1%	0%	0%	1%	0%
2265001010	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; Motorcycles: Off-road	Motorcycle	12%	0%	0%	37%	17%
2265001030	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; All Terrain Vehicles;	ATVs	33%	0%	0%	12%	37%
2265001060	Off-highway Vehicle Gasoline, 4-Stroke; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	27%	6%	6%	11%	-26%
2265002000	Off-highway Vehicle Gasoline, 4-Stroke; Construction and Mining Equipment	Large S-I	12%	5%	5%	8%	29%
2265004000	Off-highway Vehicle Gasoline, 4-Stroke; Lawn and Garden Equipment	Large S-I	10%	6%	6%	0%	2%
2265005000	Off-highway Vehicle Gasoline, 4-Stroke; Agricultural Equipment	Large S-I	32%	3%	3%	23%	53%
2265006000	Off-highway Vehicle Gasoline, 4-Stroke; Commercial Equipment	Large S-I	6%	4%	4%	4%	3%
2265008000	Off-highway Vehicle Gasoline, 4-Stroke; Airport Ground Support Equipment	Large S-I	42%	0%	0%	46%	81%
2267001060	Off-highway LPG; Recreational Equipment; Specialty Vehicles/Carts	Large S-I	83%	0%	0%	77%	83%
2267002000	Off-highway LPG; Construction and Mining Equipment	Large S-I	94%	0%	0%	90%	92%
2267003000	Off-highway LPG; Industrial Equipment	Large S-I	95%	6%	6%	91%	93%
2267004000	Off-highway LPG; Lawn and Garden Equipment	Large S-I	95%	0%	0%	90%	92%
2267005000	Off-highway LPG; Agricultural Equipment	Large S-I	92%	0%	0%	87%	90%
2267006000	Off-highway LPG; Commercial Equipment	Large S-I	91%	0%	0%	84%	91%
2267008000	Off-highway LPG; Airport Ground Support Equipment	Large S-I	95%	0%	0%	90%	92%
2268002000	Off-highway CNG; Construction and Mining Equipment	Large S-I	93%	0%	0%	88%	91%
2268005000	Off-highway CNG; Agricultural Equipment	Large S-I	94%	0%	0%	90%	92%
2268006000	Off-highway CNG; Commercial Equipment	Large S-I	92%	0%	0%	88%	90%
2270001000	Off-highway Vehicle Diesel; Recreational Equipment	C-I	67%	60%	60%	61%	41%
2270002000	Off-highway Vehicle Diesel; Construction and Mining Equipment	C-I	74%	49%	49%	55%	59%
2270003000	Off-highway Vehicle Diesel; Industrial Equipment	C-I	74%	41%	41%	38%	53%
2270004000	Off-highway Vehicle Diesel; Lawn and Garden Equipment	C-I	78%	60%	60%	57%	49%
2270005000	Off-highway Vehicle Diesel; Agricultural Equipment	C-I	79%	66%	66%	64%	63%
2270006000	Off-highway Vehicle Diesel; Commercial Equipment	C-I	76%	57%	57%	55%	49%
2270007000	Off-highway Vehicle Diesel; Logging Equipment	C-I	65%	37%	37%	53%	61%
2270008000	Off-highway Vehicle Diesel; Airport Ground Support Equipment	C-I	73%	51%	51%	58%	66%
2285002015	Railroad Equipment; Diesel; Railway Maintenance	C-I	75%	61%	61%	66%	64%
2285004015	Railroad Equipment; Gasoline, 4-Stroke; Railway Maintenance	Large S-I	5%	0%	0%	3%	4%
2285006015	Railroad Equipment; LPG; Railway Maintenance	Large S-I	94%	0%	0%	90%	92%

[1] The control factor incorporates values for both control efficiency and rule penetration.

Table D-3. Commercial Sector Compression Ignition Engines < 50 HP

Tier Category	1999	2010	2010 Adjusted[1]
Tier 2		178062	178062
Tier 1	6690	105563	104552
Base	442464	165530	
Total	449154	449154	

[1]Tier 1 engines adjusted to reflect the fraction of 1999 engines that are still operating in 2010, since some percentage will be scrapped. These are the number of engines to which costs are applied.

Table D-4. Percentage of Engines Scrapped by Equipment Category, Horsepower Range and Implementation Year For Adjusting Turnover Rates for Tier 1 C-I Engines

SCC	Equipment Description	HP Range	2010 % Scrapped	2015 % Scrapped	2020 % Scrapped	2030 % Scrapped
2270001000	Recreational Equipment	< 50 hp	7.9	12.7	19.3	75.5
2270001000	Recreational Equipment	>=100 <175 hp	3.9	5.9	8.1	13.4
2270001000	Recreational Equipment	>=175 <600 hp	3.9	5.9	8.1	13.4
2270001000	Recreational Equipment	>=50 <100 hp	7.9	12.7	19.3	75.5
2270001000	Recreational Equipment	>=600 <750 hp	2.5	3.8	5.1	8
2270001000	Recreational Equipment	>=750 hp	2.5	3.8	5.1	8
2270002000	Construction and Mining Equipment	< 50 hp	88.2	100	100	100
2270002000	Construction and Mining Equipment	>=100 <175 hp	24.8	82.2	93.6	100
2270002000	Construction and Mining Equipment	>=175 <600 hp	34.3	87.1	97.3	100
2270002000	Construction and Mining Equipment	>=50 <100 hp	92.0	100	100	100
2270002000	Construction and Mining Equipment	>=600 <750 hp	16.6	63.3	84.8	99.6
2270002000	Construction and Mining Equipment	>=750 hp	21.0	77.6	90.6	100
2270003000	Industrial Equipment	< 50 hp	93.6	100	100	100
2270003000	Industrial Equipment	>=100 <175 hp	55.2	88.5	98.5	100
2270003000	Industrial Equipment	>=175 <600 hp	67.1	90.0	99.8	100
2270003000	Industrial Equipment	>=50 <100 hp	97.7	100	100	100
2270003000	Industrial Equipment	>=600 <750 hp	19.0	73.7	88.4	100
2270003000	Industrial Equipment	>=750 hp	19.1	73.9	88.5	100
2270004000	Lawn and Garden Equipment	< 50 hp	70.9	91.2	100	100
2270004000	Lawn and Garden Equipment	>=100 <175 hp	11.0	19.1	57.1	89.2
2270004000	Lawn and Garden Equipment	>=175 <600 hp	12.0	21.5	70.4	91.6
2270004000	Lawn and Garden Equipment	>=50 <100 hp	36.6	87.6	97.8	100
2270004000	Lawn and Garden Equipment	>=600 <750 hp	8.7	14.2	22.4	80.5
2270004000	Lawn and Garden Equipment	>=750 hp	5.9	9.2	13.2	25.8
2270005000	Agricultural Equipment	< 50 hp	81.4	96.7	100	100
2270005000	Agricultural Equipment	>=100 <175 hp	9.4	15.7	25.9	83.8
2270005000	Agricultural Equipment	>=175 <600 hp	9.4	15.7	25.9	83.8
2270005000	Agricultural Equipment	>=50 <100 hp	62.4	89.1	99.0	100
2270005000	Agricultural Equipment	>=600 <750 hp	6.5	10.3	14.9	34.0
2270005000	Agricultural Equipment	>=750 hp	9.8	16.5	28.2	85.3
2270006000	Commercial Equipment	< 50 hp	84.9	99.1	100	100
2270006000	Commercial Equipment	>=100 <175 hp	93.8	100	100	100
2270006000	Commercial Equipment	>=175 <600 hp	8.6	14.0	21.8	79.7
2270006000	Commercial Equipment	>=50 <100 hp	100	100	100	100
2270006000	Commercial Equipment	>=600 <750 hp	74.4	92.7	100	100
2270006000	Commercial Equipment	>=750 hp	4.8	7.4	10.4	18.1
2270007000	Logging Equipment	< 50 hp	100	100	100	100
2270007000	Logging Equipment	>=100 <175 hp	95.9	100	100	100
2270007000	Logging Equipment	>=175 <600 hp	95.9	100	100	100
2270007000	Logging Equipment	>=50 <100 hp	96.6	100	100	100
2270007000	Logging Equipment	>=600 <750 hp	78.4	94.8	100	100
2270007000	Logging Equipment	>=750 hp	78.4	94.8	100	100
2270008000	Airport Equipment	< 50 hp	98.3	100	100	100
2270008000	Airport Equipment	>=100 <175 hp	63.1	89.2	99.0	100
2270008000	Airport Equipment	>=175 <600 hp	63.1	89.2	99.0	100
2270008000	Airport Equipment	>=50 <100 hp	98.3	100	100	100
2270008000	Airport Equipment	>=600 <750 hp	15.8	38.4	83.3	98.5
2270008000	Airport Equipment	>=750 hp	15.8	38.4	83.3	98.5
2285002015	Railroad Equipment	< 50 hp	24.8	82.2	93.6	100
2285002015	Railroad Equipment	>=100 <175 hp	9.5	15.8	26.2	84.0
2285002015	Railroad Equipment	>=175 <600 hp	9.5	15.8	26.2	84.0
2285002015	Railroad Equipment	>=50 <100 hp	24.8	82.2	93.6	100
2285002015	Railroad Equipment	>=600 <750 hp	5.9	9.1	13.0	25.1
2285002015	Railroad Equipment	>=750 hp	5.9	9.1	13.0	25.1

Table D-5. NONROAD Model Default Scrappage Curve

Frac Median Life Used	Percent Scrapped
0.0588	1
0.1694	3
0.271	5
0.3639	7
0.4486	9
0.5254	11
0.5948	13
0.657	15
0.7125	17
0.7617	19
0.8049	21
0.8425	23
0.875	25
0.9027	27
0.9259	29
0.9451	31
0.9607	33
0.973	35
0.9824	37
0.9894	39
0.9942	41
0.9973	43
0.999	45
1	50
1.001	55
1.0027	57
1.0058	59
1.0106	61
1.0176	63
1.027	65
1.0393	67
1.0549	69
1.0741	71
1.0973	73
1.125	75
1.1575	77
1.1951	79
1.2383	81
1.2875	83
1.343	85
1.4052	87
1.4746	89
1.5514	91
1.6361	93
1.729	95
1.8306	97
1.9412	99
2	100

Table D-6. Near-term Costs for Compression-Ignition Engines

Engine HP Range	Costs per Engine, $ 1998*		
	Tier 1	Tier 2	Tier 3
< 50 hp	56	136	NA
> or = 50 and < 100 hp	229	478	760
> or = 100 and < 175	229	1,095	1,753
> or = 175 and < 600 hp	229	1,033	1,905
> or = 600 and < 750 hp	229	2,899	5,195
> or = 750 hp	229	1,316	NA

*Costs apply to all C-I engine categories/applications, and are incremental to the base technology type.

Table D-7. Near-term Costs for Large Spark-Ignition Engines

SCC	Tech Type*	Costs per Engine, $ 2001**
2260000000	G4GT251	800
2260000000	G4GT252	847
2265000000	G4GT251	800
2265000000	G4GT252	847
2285004015	G4GT251	800
2285004015	G4GT252	847
2267000000	LGT251	550
2267000000	LGT252	577
2268000000	NGT251	550
2268000000	NGT252	577
2285006015	LGT251	550
2285006015	LGT252	577

*Technology types ending in "1" correspond to Phase I of the standards, with an implementation year of 2004, while technology types ending in "2" correspond to Phase II of the standards, with an implementation year of 2007.
**Costs are incremental to the base technology type.

Table D-8. Near-term Costs for Land-Based Recreational Engines

SCC		Tech Type	Cost per engine, 2001 $*	Cost Basis
2260001010	2-Stroke Gasoline Off-Highway Motorcycles	R14S1	296	Sum of 2-stroke to 4-stroke conversion, pulse air/recalibration, and compliance costs
2265001010	4-Stroke Gasoline Off-Highway Motorcycles	R14S1	46	Sum of pulse air/recalibration and compliance costs
2260001020	2-Stroke Gasoline Snowmobiles	R12S1	57	Sum of engine modifications, modified carburetor, and compliance costs
2260001020	2-Stroke Gasoline Snowmobiles	R14S	823	Sum of 2-stroke to 4-stroke conversion, electronic fuel injection, and compliance costs
2260001020	2-Stroke Gasoline Snowmobiles	R12S2	317	Sum of direct fuel injection costs and compliance costs
2260001030	2-Stroke Gasoline ATVs	R14S1	378	Sum of 2-stroke to 4-stroke conversion, pulse air, and compliance costs
2265001030	4-Stroke Gasoline ATVs	R14S1	47	Sum of pulse air and compliance costs

*All costs are weighted by sales in displacement categories, and are incremental to the base technology type

APPENDIX E: EXPORTED MEASURES COLUMN DESCRIPTIONS

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CSM Export

Column Name	Description
capcost	Capital Cost
cpton	Cost Per Ton
msa	MSA
fipsst	State FIPS
fipscnty	County FIPS
sic	SIC
naics	NAICS
sector	sector
scc	SCC
plantid	Plant ID
plantname	Plant Name
pointid	Point ID
boilcap	Boiler Capacity
capunits	Capacity Unit
oplbr	Operating Labor Costs
mntlbr	Maintenance Labor Costs
spvlbr	Supervisor Labor Costs
mntmtl	Maintenance Material Costs
rplmtl	Replacement Material Costs
elec	Electricity Costs
steam	Steam Costs
fuel	Fuel Costs
wstdsp	Waste Disposal Costs
chem	Chemical Costs
omatl	Other Raw Material Costs
util	Other Utility Costs
tdir	Total Direct Annual Costs
ovrhd	Overhead Costs
admin	Administrative Costs
proptx	Property Tax Costs
insrnc	Insurance Costs
tindir	Total Indirect Annual Costs

The grey columns are only exported if the OM Cost checkbox is selected.

LCM Export

Column Name	Description
rec_number	Record Number
cntl_meas	Control Measure
source	ACN Source Category
emis_tpy	Annual Baseline Emissions(Tons)
reduction	Current Control Reduction
inc_redn	Incremental Control Reduction
final_emis	Emissions After Control
prct_CE	Control Efficiency (%)
tcost	Total Annualized Cost
incre_cost	Incremental Annualized Cost
cpton	Cost Per Ton
MSA	MSA
fipsst	State FIPS
fipscnty	County FIPS
sic	SIC
naics	NAICS
sector	sector
scc	SCC
plantid	Plant ID
plantname	Plant Name
pointid	Point ID
stack	Stack
segment	Segment
c_emis	Cumulative Emissions
c_redn	Cumulative Reduction
c_inc_redn	Cumulative Incremental Reduction
c_final_em	Cumulative Final Emissions
c_tcost	Cumulative Annual Cost
c_inc_cost	Cumulative Incremental Annual Cost
c_cpton	Cumulative Annual Cost Per ton

Report Export

Column Name	Description
cntl_meas	Control Measure
source	ACN Source Category
emis_tpy	Annual Baseline Emissions(Tons)
reduction	Current Control Reduction
final_emis	Emissions After Control
prct_CE	Control Efficiency (%)
tcost	Total Annualized Cost
cpton	Cost Per Ton
c_emis	Cumulative Emissions
c_redn	Cumulative Reduction
c_final_em	Cumulative Final Emissions
c_tcost	Cumulative Annual Cost
c_cpton	Cumulative Annual Cost Per ton

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APPENDIX F: EXTERNAL TOOLS USED TO CREATE AIRCONTROLNET MAPPING AND GRAPHING CAPABILITIES

In addition to Microsoft Visual FoxPro, the AirControlNET application uses two supplementary software products to create the mapping and graphing capabilities within the tool. The first is Graphics Server (www.graphicsserver.com) which is used to automate the creation of customizable plots within the least cost module. The second is Scalable Vector Graphic (SVG) (www.adobe.com/svg/main.html) is used to provide the mapping capabilities within AirControlNET.

Graphics Server and AirControlNET Graphs

AirControlNET can create two types of graphs from LCM query – "Annualized Total Cost vs. Total Reductions (in tons)" and "$ / ton vs. Total Reductions (in tons)". The two graphs available for display and export from the LCM are created using a third-party module named "Graphics Server". Graphic Server is a graphing tool used by Windows developers to automate the creation of numeric graphs. It is used for adding graphs and charts to Windows and Web applications in Visual Studio, Visual Basic, C^{++}, Delphi, FoxPro and other languages. This robust graphing module can display a wide variety of graphs and provides a runtime property page for dynamically altering settings, and export several image formats.

For Annualized Total Cost vs. Total Reductions graph, cumulative incremental cost and cumulative incremental reductions data are used as dependent and independent data of the graphs respectively. For $ / ton vs. Total Reductions (in tons) graph, Cost per ton and total reductions (in tons) are used as dependent and independent data of graphs respectively. Cumulative calculation for incremental cost and incremental reduction are performed in Least Cost Module. AirControlNET only displays graphs for the Least Cost Module. Since graph calculation uses cumulative incremental data, graphs can only be created from data query in Least Cost Module.

When AirControlNET is instructed to display a graph, the specified data is extracted from the currently displayed grid in the LCM and is inserted into the graphs data arrays. Due to a limitation in Graphics Server, all graphs are capped at having 32,000 entries. This means that all graphs will display up to the first 32,000 rows in any LCM grid. Once the data has been inserted into the graph, ACN sets default labels and displays the graph window. The AirControlNET graph window contains an instance of the Graph ActiveX control, a edit box used for listing the query criteria, a properties button, and an export button. The graph properties can be altered by clicking the properties button which launches the graphics server property pages. Exporting is also handled by a graph function and is initiated by clicking the Export button.

Scalable Vector Graphic and AirControlNET Mapping Capabilities

Scalable Vector Graphics (SVG) is used to create real-time mapping capabilities within AirControlNET. SVG is a text-based graphics language that describes images with vector shapes, text, and embedded raster graphics. SVG files are compact and provide high-quality graphics on the Web, in print, and on resource-limited handheld devices. In addition, SVG supports scripting and animation, so is ideal for interactive, data-driven, personalized graphics. SVG is a royalty-free vendor-neutral open standard developed under the W3C (World Wide Web Consortium) Process.

When controls are selected in the Control Scenarios Module or displayed in the Least Cost Module grid, the AirControlNET mapping module becomes available. The map setup window that is displayed allows the user to set various map options. When the View Map or Save Map button is clicked, a SVG map file is created containing the specified data from either the CSM or LCM.

AirControlNET maps are composed by concatenating intermediate SVG files developed by Pechan. Before runtime map creation can happen, these intermediate SVG files, which will be dubbed "the base map" from here on, need to be created. The first step in creating the base map is accomplished using ESRI's ArcView, a GIS application, to extract all necessary geographic objects.

First, ArcView is used to create a map containing states, counties, MSAs, and all of the optional map layers (Tribal areas, National Parks, Class1 Tribes, Class1 NPS, Class1 Forest Service, Class1 Fish and Wildlife Services, Interstates, Railroads, Rivers, and Lakes). Then, an extraction script is used to export every layer to an initial SVG file. The extraction script, using the ArcView API, creates a SVG text file, determines the map's coordinate system, and then exports all shapes layers by layer by executing the following steps:

Obtain and iterate through the layer list

1. For the current layer, obtain and iterate through the shape list (e.g. a list of the counties in the county layer)
2. If the current shape is a collection of points, create a SVG point object, otherwise create a SVG path object
3. For the current shape, obtain, iterate through, and write out all vertices in the vertex list

The second step in creating the base SVG map is to separating each of the exported layers into their own files. Currently, this is a manual process accomplished using any text editor. Now, the initial map is ready to be developed.

AirControlNET maps are composed of a title bar and a tab controlled view which has two modes: map (default) and notes. The notes view is filled at runtime and during development is a blank page. The map view is split into two areas: the control panel and the map canvas. The control panel contains the map thumbnail, pollutant combo box, legend, and layer check boxes. The map thumbnail is used to zoom and pan the viewable area of the map canvas. The pollutant combo box allows the user to switch the pollutant the map is shaded by. When a new pollutant is selected, the legend is also updated. The legend consists of eight entries each consisting of a color indicator and a value. All features (states, counties, or MSAs) with data less than the specified legend value and greater than the previous value use the specified color. At runtime, the user has an option to specify the number of ranges, or legend entries, to use which is always between there and eight. The layer check boxes are used to show and hide the map layers. Every map has a state layer, which is always on, county layer, and a MSA layer. The optional layers, also selected at run time, can be turned on an off if they are loaded into the map.

Once the initial SVG and script code is written, the map is split into intermediate SVG files (i.e. the "base map"). These files are split around two main sections of the initial map: the script section and optional layers section. When creating a map, AirControlNET concatenates the first intermediate file with the map data which is represented as arrays at the beginning of the script section. The resulting text and the next intermediate file are appended. This process is repeated with the optional SVG layers and the final intermediate file. When complete, the new AirControlNET map is displayed.

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